NATURE

No. 4377 SATURDAY, SEPTEMBER 19, 1953 Vol. 172

CONTENTS

	Page
National Parks in Britain	511
Role of Nitrogen in Plants. By Prof. A. C. Chibnall, F.R.S.	513
Physics of the Ionosphere. By C. M. Minnis	514
Physics and Physiology of Nervous Activity. By Prof. D. Whitteridge, F.R.S.	515
Stability and Control. By Prof. G. Temple, F.R.S.	515
Advances in Catalysis. By Dr. James Bell	516
Science and Ethics. By the Most Rev. and Right Hon. Cyril F. Garbett, Archbishop of York	517
Measurement of the γ Radiation from the Human Body. By Dr. P. R. J. Burch and Prof. F. W. Spiers	519
Determination of Total Body Radioactivity using Liquid Scintillation Detectors. By F. Reines, R. L. Schuch, C. L. Cowan, jun., F. B. Harrison, E. C. Anderson and F. N. Hayes	521
Obituaries :	
Prof. H. E. Fierz-David. By Prof. John Read, F.R.S.	523
Mr. W. N. Croft. By W. N. Edwards	523
News and Views	524
Medium-Energy Nuclear Physics : Conference at the University of Pittsburgh. By Philip Stehle	527
American Aid for Scientific and Industrial Research in Great Britain	528
American Philosophical Society : Year Book for 1952	529
Standard Frequency Transmissions from the United Kingdom	529
John Henry Newman and Science. By Dr. W. L. Sumner	530
Structural Basis of the Cross-striations in Muscle. By Dr. Jean Hanson and Dr. Hugh E. Huxley	530
Evidence of Harmonics in the Spectrum of a Solar Radio Outburst. By J. P. Wild, J. D. Murray and W. C. Rowe	533
A Macroscopic Theory of Interference and Diffraction of Light from Finite Sources. By Dr. E. Wolf	535
Seismic Refraction Experiments in the Indian Ocean and in the Mediterranean Sea. By Dr. T. F. Gaskell and J. C. Swallow	535
Letters to the Editors :	
Relation between Frank Spirals and Spiral Pits in Crystals.—S. Amelinckx and E. Votava	538
Radio Radiation from the Supergalaxy.—Prof. J. D. Kraus and H. C. Ko	538
Remanent Magnetism of Varved Clays from Sweden.—D. H. Griffiths	539
Generation of Weak Shock Waves.—Dr. V. Timbrell	540
Nucleic Acid Template Hypotheses.—Prof. Alexander L. Dounce ; Dr. T. S. Work and Dr. P. N. Campbell	541
Origin of Striations in Discharges.—Dr. G. D. Morgan	542
High-frequency Papyrography of Salts.—Dr. Yohei Hashimoto and Itsohiko Mori	542
Influence of Cations on the Ninhydrin Reaction for the Determination of Amino-Acids.—Dr. Hanan Meyer and Emanuel Riklis	543
Riboflavine and Thiamine Contents of Saffron, *Crocus sativus* Linn.—Prof. J. V. Bhat and Rajul Broker	544
Fibrinolysis by Adsorption.—Dr. George R. Fearnley	544
Effect of Diuresis on Uptake of Radioiodine (^{131}I) by the Thyroid.—Dr. J. Pahaut, Dr. J. Govaerts and Dr. P. Bonhomme	545
Hydrophilic Penicillins produced by *Penicillium chrysogenum*.—Dr. C. W. Hale, G. A. Miller and B. K. Kelly	545
Depletion of Gamma Isomer of Benzene Hexachloride in Cattle Dipping-Fluids.—W. J. Roulston and L. F. Hitchcock	546
Non-identity of Intermedin and Adrenocorticotrophic Hormone.—Prof. A. O. M. Stoppani, P. F. Pieroni and A. Murray	547
Origin and Fate of the Virus Bundles in Nuclear Polyhedroses.—N. Xeros	548
Effect of Galvanic Polarization on the Impulse Discharge from the Horizontal Ampulla of the Isolated Elasmobranch Labyrinth.—Prof. Otto Lowenstein	549
Occurrence in Nature of an Alternative Host (*Leersia hexandra* Sw.) of *Helminthosporium oryzae* Breda de Haan.—Dr. S. B. Chattopadhyay and N. K. Chakraborti	550
Activity of the Incretory Centres of *Locustana pardalina* during Embryogenesis : Function of the Prothoracic Glands.—Dr. Bryn M. Jones	551
Sorghum Midge and Resistant Varieties in the Gold Coast.—J. Bowden and R. A. Neve	551
Heartwood Formation in *Pinus radiata* (D. Don).—J. Maddern Harris	552
Sterilization of Timber with Methyl Bromide.—J. B. Cartwright, D. W. Edwards and M. J. McMullen	552
Testing of Two Samples.—Dr. P. V. Krishna Iyer	553

NATIONAL PARKS IN BRITAIN

THE debate on national parks which took place in the House of Lords on May 19 had at least the merit of re-directing attention to the weakness in organization of the National Parks Commission, which the third report of the Commission had again emphasized. Little exception could be taken to the trend of Lord Mancroft's reply on behalf of the Government : he was manifestly anxious that the whole project should succeed, though the sincerity of his concern over the education of the public in 'country behaviour' could well be attested by more reasonable financial support for the Commissioners in their publicity. Lord Silkin, however, whose motion initiated the debate, was a little disingenuous in his disappointment that the idea of national parks in Great Britain had not been received by the public as well as had been hoped. He might with more honesty have recognized that some measure of responsibility lay with his own failure to make the National Parks Commission a stronger body with executive functions of its own and reasonable financial resources, so that its activities were not limited by the meagre resources of such counties as Westmorland or Merioneth. Indeed, when he deplored the absence of wardens to check the litter left at some beautiful places of popular resort, he might well have remembered his own responsibility for the restraint on the appointment of wardens by park boards to 'access land', that is to say, wild, uncultivated land, to which public access has been given by a specific agreement or order.

While, however, Lord Mancroft can argue with reason that the Commission is wise to feel its way gently in the first years of its life, the pace of change in the countryside is accelerating and is already threatening the loveliness of even the more remote moorland, downland, and coastal districts of Britain. Moreover, the growing threat comes in the main from government departments, public authorities and large industrial undertakings, which the National Parks Commission has no effective means of checking or controlling. Further, its allies in the defence of amenity like the National Trust, the Council for the Preservation of Rural England and others are dependent on voluntary public support and have already liabilities which exceed their limited income. The Council for the Preservation of Rural England had an income of only £5,843 in 1952–53 and an expenditure of £6,370* ; its Sheffield and Peak District Branch† had an income of £1,630 and an expenditure of £1,459. Like the National Trust, the Council and its branches urgently need a considerable increase in membership if they are to continue to carry on their work effectively even on the present scale.

* Council for the Preservation of Rural England. Twenty-seventh Annual Report, 1952–53. Pp. 60+4 plates. (London : Council for the Preservation of Rural England, 1953.)

† Council for the Preservation of Rural England, Sheffield and Peak District Branch. Annual Report 1953. Pp. 28. (Sheffield : Mrs. G. Haythornthwaite, Hon. Secretary, Endcliffe Vale House, 1953.)

Awareness of all this lies at the root of the unresolved conflict between amenity and development or other claims on the use of the land; nor is it obvious how to check undesirable developments without hindering legitimate change. It is for this reason that Lord Mancroft's claim that the number of parks already designated represents a considerable achievement would be received with some scepticism, even had the safeguards of independent park planning boards been rigorously applied. It is idle to pretend that parks exist where, in fact, they are little more than paper plans. Not merely the House of Lords debate and the reports that have already come from the National Parks Commission, but also the first report of the Peak Planning Board and the annual reports for 1952–53 of the Council for the Preservation of Rural England and of its Sheffield and District Branch fully confirm the desirability of an early overhaul of the powers of the National Parks Commission; only in this way can some sense of reality be brought into the whole question of planning before the balance has been irretrievably destroyed by unilateral action and decisions taken by interested parties.

Development, complains the Peak Planning Board, has caused considerable injury to some of the finest scenery in this, the first of the national parks. Too many buildings, and unsuitable material for them, are permitted. Widespread destruction of amenities and of agricultural values is feared from clay working, and in spite of emphatic objections from the Peak Board, the National Coal Board was allowed to prospect for open-cast coal, although open-cast working within the Park was successfully opposed by the Peak Board. Details recur in the report of the Sheffield and Peak District Branch of the Council for the Preservation of Rural England, which tells also of efforts to curb the growing threats from lime quarrying and cement works, and the danger to the grandest scenery of the Derwent, including the Cutgate Pass from water schemes; to Sheffield's Green Belt from housing developments; and to Bakewell's river pastures from a proposal to revive an abandoned scheme for a by-pass road.

Two points are worth noting in this connexion: first, the burden which the public inquiries place on the amenity societies. The Sheffield and Peak District Branch, for example, had to face seven public inquiries within six weeks, one of which lasted four days, and the annual report rightly directs attention to the unequal position of the voluntary defenders of the scenic heritage of Great Britain opposing powerful interests, who not infrequently have been also the judges in their own cause. Secondly, this difficulty has arisen in the earliest of the national parks, where the vigour and effectiveness of the Joint Planning Board have already won it the warm support of some of those who most strongly opposed its formation. Similar dangers, however, threaten areas like Snowdonia, Dartmoor and the Lake District, where the system of management is far less satisfactory, and hydro-electric schemes or claims for training areas have weaker opposition to face.

Few can now entertain the idea that 'designation' as a national park or Nature reserve confers an absolute safeguard against loss of natural beauty. So far the attempts made to balance practical considerations against the preservation of amenity have led to such confusion and frustration that the impression might well be gained that designation increases the risk of destruction of natural beauty. To say the least—and without challenging the condition that inclusion of land in a park effects no change in ownership or right of public access, or the need for proper safeguards for the interests of agriculture, forestry, transport, industry and for other public needs in the areas concerned—it may well be held that in practice the claims of amenity have been put so low that the value of declaring an area a national park, under present conditions, is extremely dubious.

How far the damage already done is irreparable may be a matter of opinion; but clearly attrition, particularly in those areas like Dartmoor where the park is entirely under local authority control and the first consideration appears to be the avoidance of any charge to local ratepayers, is proceeding at a rate which will not brook delay. To safeguard the Norfolk Broads, for example, demands early action and cannot be postponed indefinitely as Lord Mancroft seemed to imply. Lord Chorley apart, there was little sense of urgency apparent in the House of Lords debate, and it is evident that an upsurge of public opinion is required to compel the Government to give adequate attention and resources to the whole question.

There can be little doubt that the presence of the National Parks Act and Access to the Countryside Act on the Statute Book has given a false sense of security in this matter to the general public, and the most strenuous efforts of the Commission itself and of the amenity societies will be required to secure appropriate action before Britain's scenic heritage, to say nothing of its flora and fauna, are irretrievably damaged. In these circumstances it is the more unfortunate that the membership of bodies like the National Trust and the Council for the Preservation of Rural England is comparatively so small and shows such slight signs of increase. A significant rally to the support of such bodies and a marked increase in their membership could give clear warning to the Government that the defence of amenity is not merely a concern of a tiny minority, but one in which a large and active body of citizens is deeply interested.

Apart from this, such voluntary bodies have an important function to perform in the defence of amenity even if the National Parks Commission is strengthened and the administration of the Parks placed on the basis which was recommended by the Hobhouse report. The annual report of the Council for the Preservation of Rural England shows clearly how much will still remain to be done by voluntary bodies in the way of investigation and negotiation for the purpose of finding practicable and acceptable solutions to the real problems which arise when natural beauty is challenged by some other public need. It is not merely that bodies like this Council

have a wider orbit than any particular park planning authority, however constituted, or even than the National Parks Commission itself. The defence of amenity is properly the concern of every good citizen, and it is fitting that the defence should be rooted deeply in local knowledge. Nor can the park boards or the Ministry of Housing and Local Government be expected to carry out the unspectacular work which can do so much to reconcile in part conflicting claims, or to mitigate the effect on the beauty of the countryside of an adverse decision by authority.

The work of the Council for the Preservation of Rural England in such matters as refuse dumps in rural areas, the control of camping and caravan sites, of advertising and the preservation of buildings indicates how much such a body can contribute in the way of pooling advice and experience, and securing the reconsideration of projects advanced in ignorance of possible alternatives which would cause less damage to amenity. Such work is arduous and continuous; but the present report gives several instances of its success. More could be done if the financial resources of either the Council or the National Parks Commission were greater; but even as it is, the work of the Council in such fields attests the existence of the spirit of co-operation on which the Minister of Housing and Local Government has rightly laid much stress. Such questions as road services and footpaths in the park areas provide other evidence of the possibility that a stimulus may be given which could bring fresh vitality to the whole task of local government in such areas. The success of the scheme for mapping footpaths and bridleways throughout Great Britain depends on the interest and co-operation of country lovers and users, and here also the Council for the Preservation of Rural England has been active, examining, *inter alia*, the possibility of an alternative to the proposed Thames Riverside Walk which for economic reasons the National Parks Commission had abandoned last autumn as a long-distance route.

The Council's annual report for 1952–53 gives a clear picture of some of the possibilities in all these fields, provided that it receives the backing it deserves. Already it has done, and is doing, much exploratory work that could help the National Parks Commission to deal wisely and effectively with the problems that a properly constituted park authority will have to solve at the regional and at the national level. The reports here discussed show clearly the dangers involved in the present situation, and the urgent need for disturbing the complacency which marked the House of Lords debates and has characterized official attitude to national parks hitherto. An unmistakable rally of public support to the Council and to the other societies for the protection of amenity would not only enable them to extend their work and to do it more effectively: the increase in membership might well help the Minister to change his whole attitude to national parks, and convince the Government that here is a national interest to which something more than lip service must be given.

ROLE OF NITROGEN IN PLANTS

Nitrogen in the Life of Plants

By Dr. Dimitrii Prianischnikov. Translated by S. A. Wilde. (U.S.S.R.: Academy of Science; Madison, Wis.: Kramer Business, Inc.)

DIMITRII PRIANISCHNIKOV, who died in 1948 at the age of eighty-three, was probably the last of the great pioneers in the application of chemistry to problems of fundamental agricultural importance. For more than fifty years he had been at work at the Timiriazev College of Agriculture near Moscow and, trained as he was under Timiriazev himself, he was a direct link with Boussingault, whom he met, and with Liebig. When he started research under Ernst Schulze at Zurich in 1892 on the role of nitrogen in the life of plants the number of simple nitrogenous substances that had been isolated from plant material was not very large, and ideas about protein structure and metabolism were rudimentary. The application of nitrogenous dressings in agronomy was, of course, already well known, but the great advance that followed the introduction of cheap synthetic products for this purpose was to come later. The book under review, written when he was nearly eighty, is cast largely in the form of a personal narrative, and in it he portrays the history of the subject as it unfolded during his lifetime and incidentally shows us the important part that he himself played in its development. It is a 'period piece' to be treasured as well as read with profit by those who would follow in his footsteps.

In the first chapter he discusses the early history of the nitrogen problem in plants from the time of Glauber, and his interpretation of the literature leads him to conclude that Boussingault has a greater right even than Liebig to be regarded as the founder of modern agrochemistry, in that he was a more exact experimentalist than Davy and had views on the nitrogen nutrition in plants which were well ahead of those of Liebig. In the next chapter he discusses the early work on the forms of nitrogen available to plants, and gives a brief summary of the controversies that arose between Boussingault, Liebig and others as to the role of ammonia and nitrate in plant nutrition and on the question of nitrification in the soil. He again directs attention to the more exact experimental techniques employed by Boussingault.

The third chapter, dealing with the role of ammonia and amides in plant metabolism, is, perhaps, the most valuable one in the book because, *inter alia*, he gives us for the first time and fifty years after the event his own version of the controversy that he had with his old teacher Schulze on the chemical mechanisms leading to the production of asparagine in germinating seedlings. For more than twenty years before Prianischnikov went to work with him, Schulze had been laboriously isolating and estimating the asparagine and amino-acids present in seedling saps, and had obtained much evidence that was in direct contradiction to the concept, widely held by contemporary plant physiologists under the masterful leadership of Pfeffer at Leipzig, that the amide was a primary product of protein decomposition. In his opinion the amino-acids were the primary products and asparagine was derived from these by a secondary process about which he hesitated to express dogmatic views.

Prianischnikov, who started a series of comprehensive seedling analyses in Schulze's laboratory in 1892, and continued them on his return to Moscow, put forward the suggestion, based on reasonable but indirect evidence, that the essential intermediate in this secondary process was ammonia. Schulze, who had himself adumbrated the same idea in 1888, but had been unwilling to adopt it for lack of direct chemical evidence, was unconvinced, and was to remain so until Prianischnikov and his pupils produced, in the years between 1905 and 1912, what was probably valid, though still indirect, evidence that some oxidative mechanism was concerned. In his account of the development of the subject during the twenty years 1892–1912 the reviewer is of the opinion that Prianischnikov has perhaps been just a little ungracious to his old teacher. In his earlier years Schulze had been strongly influenced by the work and philosophical approach of the first great master in protein chemistry, Ritthausen, whose book "Die Eiweisskörper der Getreidarten, Hulsenfrüchte und Ölsamen", published in 1872, he regarded as a landmark. He was convinced that the interpretation of plant metabolism must be based on sound chemical observation and was thus led to spend most of his life combating what was to him the evil influence of the speculation that was rife at that period in the literature of plant physiology.

Prianischnikov, as a younger man, must have found Schulze's views dull and rather unimaginative, just as the casual reader of Schulze's numerous papers would do to-day. In the event his interpretation of the role of ammonia in asparagine production has been shown to be correct; but some of the evidence that he advances in support of it in his book (pp. 18, 19) is culled from Schulze's earlier work, and this is not brought out quite as clearly as it might have been. The controversy, of course, is of no more than historical interest to-day but it should never be forgotten, for these early views on the role of ammonia in amino-acid metabolism antedated by several years the more definitive work of Knoop on oxidative deamination in the animal organism. Such criticism, nevertheless, need not lessen our appreciation of Prianischnikov's own contribution, and his thesis that ammonia was the alpha and omega of protein synthesis and degradation in plants undoubtedly helped to clarify what was then a rather confused field of study. In this the influence of Boussingault, who had put forward a similar suggestion about urea in animal protein metabolism, is apparent.

In 1912 Prianischnikov abandoned work in the metabolism of organic nitrogenous compounds and was to devote the rest of his long life to investigations on ammonia and nitrate nutrition in plants, which he realized might yield results of much greater economic importance, especially to a country where agriculture was as backward as it was until recently in Russia. Much of the work that was carried out under his guidance at the Timiriazev College has been inaccessible to those who are unable to read Russian, though the outlines of it have been known to us through the summaries that he published from time to time in German journals. In the last four chapters of his book the whole subject is now treated on a historical basis and his own work is presented in expanded form. Once again we can be grateful for a long memory and his penetrating assessment of the value of much of the early literature. His own researches will have a lasting effect on agronomic practice and show that he belonged to the ranks of the world's great scientists. There can be no doubt that the contributions which he made to the economic development of his country were profound, and that the honours which came to him in his later years were well deserved.

It is an illuminating reflexion of conditions in the publishing world to-day that the English translation of this unique book should be produced in typewritten form instead of normal print. This complaint nevertheless does not lessen our gratitude to Prof. Wilde and his colleagues for having made the translation available to us.

A. C. Chibnall

PHYSICS OF THE IONOSPHERE

Die Ionosphäre

Ihre Bedeutung für Geophysik und Radioverkehr. Von Dr. Karl Rawer. Pp. 189+10 plates. (Groningen: P. Noordhoff N.V., 1952.) Paper, 12.50 florins (28*s.* 6*d.*); or cloth, 14.50 florins (32*s.* 6*d.*).

THE practical importance of the ionosphere rests on the use which the radio engineer must, perforce, make of it if he is to maintain a modern world-wide communication network. Although the continually changing characteristics of the different layers may be a constant source of anxiety to the engineer, familiarity with similar changes in the past and the use of empirical methods allow him to extrapolate current behaviour into the future with sufficient accuracy for his needs without having to study the underlying physics.

On the other hand, the changes whi h harass the engineer are grist to the mill of the physicist whose aim is to explain the behaviour of the ionosphere in terms of an atmosphere irradiated by solar ionizing radiation in the presence of the earth's magnetic field.

Books on the ionosphere are rare, probably because the number of potential readers is limited even when both physicists and engineers are included. Small though this number may be, a treatment of the subject, if it is to be successful, must be written either for the physicist or the engineer since their interests and points of view are essentially different. Dr. K. Rawer's monograph is intended primarily for the physicist who wishes to make a rapid survey of ionospheric physics and of the important problems of finding the upper and lower limiting frequencies for the propagation of radio waves through the ionosphere at oblique incidence. In a book of this size, detailed discussion of the wide range of subjects covered is not possible; but space has been found, in most cases, not only for a brief review of the background but also for an indication of more recent developments.

Dr. Rawer would, no doubt, agree with Samuel Johnson's remark that "a man will turn over half a library to make one book". Nevertheless, he has not been indiscriminate in quoting references, particularly to earlier investigations, merely for the sake of completeness; about half of the two hundred and fifty sources quoted refer to work published during the past eight years, and the inquisitive reader who wishes to examine in more detail a particular problem which interests him will find ample guidance for further study. The quality of the typography and make-up of the volume conform to the high standard expected in books published in the Netherlands.

C. M. Minnis

PHYSICS AND PHYSIOLOGY OF NERVOUS ACTIVITY

The Neurophysiological Basis of Mind

The Principles of Neurophysiology. By Prof. John Carew Eccles. (Being the Waynflete Lectures delivered in the College of St. Mary Magdalen, Oxford, in Hilary Term 1952.) Pp. xi+314. (Oxford: Clarendon Press; London: Oxford University Press, 1953.) 25*s*. net.

THIS book is the outcome of the Waynflete Lectures for 1952, a series of lectures the fame of which in the University of Oxford grew so fast that they had to be moved three times to a larger lecture theatre. The audience was swollen by philosophers and theologians who were spurred on to endure a close-knit exposition of the physics and physiology of nervous activity by the hopes engendered by the title. In the last Lecture, alas, their hopes were foiled. The crock of gold seems at present to be but rainbow gold after all.

Title apart, this is a very good book. It is an attempt to give a complete account of the processes which occur at the synapse—the junction between one cell and another. This has been the main object of the author's work for at least twenty-five years. Starting with myographic work on the flexor reflex with Sherrington, Eccles has pursued synaptic activity in the sympathetic ganglia, has studied the simpler system in the nerve muscle junction and has returned to the spinal motoneurone, continuing to attack it with better methods and better microelectrodes, until he has succeeded in introducing an electrode into the cell-body itself. He has recorded the electrical signs of excitation and inhibition at the cell membrane and has interpreted them in terms of two chemical processes which result in the breakdown or the stabilization of the cell membrane. Although there are those who do not accept his interpretation, no other interpretation is as yet so well buttressed.

There are many properties of the membrane of the cell-body which cannot be directly measured. The book therefore begins with an account of the recent work on nerve axons chiefly from Cambridge, and of the processes at the nerve-muscle junction chiefly studied by Katz and his colleagues. These are used to fill in gaps in our understanding of synaptic processes.

The author's more recent work on the prolonged effects of repetitive stimulation is used to bridge the gap between the long-known evanescent effects of 'facilitation' in simple reflexes and the almost permanent changes affected by 'learning'. His emphasis on the plasticity of the nervous system is new and most useful. He raises, but does not pursue, the problem of the differences between the effects of natural stimuli which reach the cord from the afferent endings in muscle and the synchronous volleys which can be set up in the same fibres by artificial electrical stimulation. The artificial stimulus gives rise to post-tetanic potentiation, the natural one does not.

In the later part of the book, Eccles uses the present knowledge of the synapse to illuminate and endow with life our knowledge of the cerebral cortex. He discusses at some length the work of Delisle Burns on isolated unanæsthetized slabs of cerebral cortex, and interprets his results in terms of the probable behaviour of networks of nerve cells arranged in a simple lattice structure.

Hebb has remarked that some psychologists regard the brain as having all the fine structure of a bowlful of porridge. It does not seem likely that it is much more profitable to regard the cortex as having the uniformity of structure of a crystal.

It is arguable that at present our greatest need is for some understanding of the smaller units of neuronal organization. At present we have two, the circumscribed 'centre' which experimental observations obstinately fail to support, and the reverberating chain of Cajal, brilliantly used by Lorente de Nó. The full possibilities of the chain are far from being exploited theoretically and the experimental demonstration of its existence is not easy. Forty years ago we had the reciprocally related half-centres of Graham Brown laughed out of court by the Oxford School because such centres could not be precisely localized. So far the simpler brains studied have not been simple enough to teach us much about the organization of neurones.

In his introduction to his chapters on the cortex, Eccles excludes any discussion of the basal ganglia on the rather odd ground that "they are outside the scope of this book". It is clear, however, from the work of Dusser de Barenne, McCullough and Magoun, that the cerebral cortex does what the basal ganglia and mid-brain structures permit it to do. To have some understanding of cortical processes, we need more than a knowledge of the synapse and the probable behaviour of reverberating chains of neurones. This book is synaptology at its best; but synaptology, alas, is not enough.

D. WHITTERIDGE

STABILITY AND CONTROL

The Principles of the Control and Stability of Aircraft

By Prof. W. J. Duncan. (Cambridge Aeronautical Series.) Pp. xvi+384. (Cambridge: At the University Press, 1952.) 40*s*. net.

THIS is the first volume of the new Cambridge Aeronautical Series, edited by Ernest F. Relf, which was originally planned in the College of Aeronautics at Cranfield. The author, Prof. W. J. Duncan, now Mechan professor of aeronautics and fluid mechanics in the University of Glasgow, has had a most distinguished career at the National Physical Laboratory and afterwards as professor of aerodynamics in University College, Hull, and then in the College of Aeronautics, Cranfield. He is undoubtedly one of the greatest living authorities on problems of stability and control of aircraft and of aerodynamic vibrations, and with Dr. R. A. Frazer he made the first systematic investigation of the problem of flutter, on which he is one of the outstanding experts. Through his work on the Aeronautical Research Council and its committees and sub-committees, he has been in continuous contact with the new discoveries and developments in this important branch of aeronautics, and it is difficult to think of anyone better qualified than Prof. Duncan to write an authoritative exposition of the principles of the control and stability of aircraft.

The subject itself is a most important and a complex branch of aeronautics. Unfortunately it has hitherto been almost inaccessible to students because most of the recent developments are still available only in original reports and papers and have scarcely begun to find their way into text-books.

This applies especially to the important recent developments made during and after the Second World War. The book gives a lucid and systematic exposition of a branch of aerodynamics which has hitherto been available to students almost solely through oral tradition.

The wide range of subjects covered by the author can be gathered from the fact that it includes discussions of problems of aero-elasticity (including the effects of flexibility of wing, fuselage and tail-plane), the effects of compressibility, automatic stabilization, a general survey of our knowledge of flaps, and the phenomena of stalling and spinning of aircraft. The last two topics are discussed in two chapters contributed by Prof. A. D. Young, of the College of Aeronautics, Cranfield.

The general plan of the treatise is to proceed from an elementary introduction of the mechanics of flight to the equations of motion of the rigid aircraft and to the solution of the dynamical equations and the investigation of stability. This is followed by a separate study of longitudinal-symmetric motion and lateral-antisymmetric motion. A special chapter is devoted to measurement of aerodynamic derivatives, and two other chapters to flap controls and controls for rolling, pitching and yaw. Other topics discussed in the book are static stability and manœuvrability.

There can be no doubt that this text-book is destined to become the classical reference for all problems of stability and control. Its clarity, simplicity, systematic arrangement and comprehensiveness make it an outstanding achievement of aerodynamic exposition.

G. Temple

ADVANCES IN CATALYSIS

Advances in Catalysis and related Subjects

Edited by W. G. Frankenburg, V. I. Komarewsky and E. K. Rideal. Vol. 3. Pp. xi+360. 7.80 dollars. Vol. 4. Pp. xi+457. 9.50 dollars. (New York: Academic Press, Inc., 1951 and 1952.)

THE task of providing an authoritative account of the present state of knowledge in the field of catalytic chemistry is a formidable one; but the importance of the theory, practice and industrial aspects of the subject must be held to merit the publication of the present series of volumes.

In the development of any theory of catalysis the number of factors affecting catalytic phenomena which have to be taken into account are many and varied and must include, for example, the chemical nature of solid catalysts and the structure, even the fine or electronic structure, of their surfaces, chemical and physical adsorption and desorption processes, the effects of catalyst poisons, ageing of surfaces, the formation of intermediates and the properties and behaviour of the products towards the catalyst surface. These are but a few of the variables which emphasize the complex nature of the sequence of processes occurring in a catalytic reaction.

These two volumes present articles by well-known workers on different aspects of catalysis, and the editors decided no attempt should be made to link these articles by anything approaching a universal theory. This was a wise decision, not only because of the absence, at present, of a universal theory of catalysis, but also, as the editors point out, since to do otherwise might have had the effect of hampering free expression of opinion by the authors. The result is that in both these volumes we have a stimulating blend of the theoretical aspects and the practical applications of many facets of surface catalysis.

Volume 3 contains eight articles of fascinating variety. It is pleasing to find that the first article gives a lucid account of Balandin's contributions to the consideration of the geometry of surfaces and the correlation of this with catalytic activity. There follows a discussion of the application of magnetic methods to the study of catalyst structure. Here, the experimental methods are clearly described and the resulting information critically examined.

The interest of the general reader is further stimulated by the abrupt change from the subject-matter of these two articles to that of the following one which deals with the catalytic oxidation of acetylene in air. This is an intensely practical problem and its importance lies in the application of such catalytic methods to the removal of the very small amounts of acetylene in atmospheric air in order to eliminate the explosion hazard in the manufacture of oxygen by distillation of liquid air.

The poisoning of metallic catalysts has always been a question of interest from the theoretical and the practical points of view, and a major work on surface chemistry would not be complete without consideration of this topic. The discussion, by Prof. Maxted, gives a good picture of our present state of knowledge; it is stimulating to consider this article in conjunction with a later one on nickel sulphide catalysts.

Some features of the catalytic cracking of hydrocarbons and the chemical characteristics and structure of cracking catalysts are ably dealt with in two chapters, and the volume is completed with a discussion of reaction-rates within the porous structure of solid catalysts.

In Volume 4, further problems in catalytic cracking processes are considered in two articles, one of which is devoted mainly to the sintering properties of catalysts used in these reactions.

Catalytic phenomena in homogeneous media are represented in this volume by authoritative contributions on acid-base catalysis, the free radical mechanism in the reactions of hydrogen peroxide, and the specific reactions of iron in some hæmoproteins.

Two articles on adsorption give, rather briefly, representative pictures of this important feature of catalytic problems. One of these is restricted to a review of recent aspects of the statistical thermodynamical theory of physical adsorption, while the other is concerned with the role of surface heterogeneity in adsorption.

A historical review of the catalytic synthesis of hydrocarbons from carbon monoxide and hydrogen provides a useful summary of the main steps in the development of this process. Much of the article is devoted to the work of Franz Fischer and his co-workers; but developments in other countries are also summarized, and there is a section on some solved and unsolved problems of hydrocarbon synthesis.

These two volumes are in keeping with the standard set by the earlier volumes in this series, and it seems certain that the editors' hope that they will be of very substantial help to both the specialist and the novice in the field of surface catalysis will be realized.

James Bell

SCIENCE AND ETHICS*

By the Most Rev. and Right Hon. CYRIL F. GARBETT, Archbishop of York

Use and Misuse of Science

THE history of civilization shows how man always has to choose between making the right and wrong use of the discoveries of science. This has never been more true than in our own age. In a brief period amazing discoveries have been made and applied to practical purposes. It has become a platitude to say we are living in an age of revolution. Within the life-time of many of us the social and economic life of a great part of the world has been transformed by practical science.

It would be ungrateful not to recognize how immense are the boons which science has given to mankind. It has brought within the reach of multitudes benefits and advantages which only a short time ago were the privilege of the few. It has shown how malnutrition, hunger and disease can be overcome. It has not only lengthened life, but it has also deepened its quality. Fields of knowledge, experience and recreation open in the past only to a few have been thrown open to millions. Through the work of science the ordinary man to-day has been given the opportunity of a longer and fuller life than was ever possible to his grandparents. Most thankfully we must acknowledge all that science both has done and is doing for the welfare of our race.

But the gifts of modern science can be misused as greatly as those of primitive science in the days of Lamech†, and as the gifts are greater, so their misuse can be the more catastrophic. The motor-driven vehicle facilitates business and gives harmless enjoyment to many; but it can strew the road with dead and dying—250,000 casualties in one year in Great Britain alone. The cinema is a means of instruction and recreation opening 'magic casements', but it is often a channel of vulgarity and false values. The wireless can link the world together in a moment of time, but it can also be the instrument of lying propaganda. The aeroplane makes travel rapid and easy, but it can also become a weapon of destruction.

The Dilemma of Science

It is this twofold aspect of the use to which science can be put which has raised in an acute form the question as to how far it is morally justifiable to make and apply discoveries and inventions which can be used for destruction or result in the ultimate impoverishment of man. This, if I understood it rightly, was the dilemma posed by Prof. A. V. Hill in his presidential address to the British Association last year. He summed it up in the question: "If ethical principles deny our right to do evil that good may come, are we justified in doing good when the foreseeable consequence is evil?" He drove home this question by two problems. The first was taken from the development of nuclear physics. This, rightly used, should be of the greatest value to mankind, especially if existing sources of power come to an end. But at present the development of this science is largely concerned with producing weapons, like the atomic and hydrogen bombs, of unprecedented destructive power. Is it right, therefore, to continue research on lines which may lead to fearful destruction, and is it right to keep secret the result of these researches? The other problem arises from the success of science in overcoming disease and lengthening life. Both the birth-rate and the expectation of life have been increased by the removal of the older checks of hunger and disease on the growth of population. But the supplies of world food are not increasing at the same rate. Before long, population will have outstripped the food available to feed it. When this happens the scramble for it will be intensified as the world becomes divided more than ever into 'Haves' and 'Have nots'. War for the means of existence will be inevitable, and in the fight against starvation the land will be exhausted and soil erosion will change fertile plains into dust bowls. Is it right to continue improving world health and reducing mortality if by doing so future famine and disorder become certain? These and other questions are a challenge to thoughtful men. *The Times*, in commenting on this address the next day, said it was a call for a statement of moral principles, and continued, "Theology was once known as the Queen of the Sciences. If science as the servant of humanity is to be sure of its direction, the queen needs to be either re-instated or replaced. . . . The throne is at present vacant".

Integrity and Secrecy

To the questions thus asked, Christian theology must attempt some answer, though often it cannot be clear-cut and decisive. The Christian theologian is in complete agreement with the man of science when he asserts that the fundamental principle of all research work is unbending integrity, and that evidence must be followed to its logical conclusions however disagreeable they may be. The Christian must welcome truth from whatever quarter it comes, for his Lord is the Truth as well as the Way and the Life. A sound Christian theology insists that the love of truth is as important as the practice of truthfulness. It is deeply to be regretted that sometimes Christians have forgotten this and denounced new discoveries, not because they were untrue, but because they feared they would be dangerous and unsettling to faith. The Christian has the right to criticize the validity of any theories. It may be necessary for him to suspend for a time final judgment on them; but he has no right to reject them solely because their consequences may be disconcerting. Neither Church nor State must attempt to destroy the results of scientific inquiry. The Church must not repeat the condemnation of Galileo nor the State the folly of Stalin on the Lysenko controversy on heredity.

The unrelenting search for truth does not, however, carry with it the conclusion that when discovered it must at once be proclaimed to all and sundry. Men of science have always taken pride in the universal nature of their work; in the past they recognized no national or geographical boundaries, and they were able freely to exchange information with fellow workers in different lands. It is therefore repugnant

* Substance of a sermon preached in Liverpool Cathedral on September 6, on the occasion of the meeting of the British Association.

† Genesis, iv, 23, 25.

to them when secrecy is imposed upon them. With this position Christianity fully agrees, for as it teaches the Fatherhood of God and the brotherhood of man, we should share unselfishly with others our knowledge and advantages. But Christian theologians have also recognized that there must sometimes be delay or reservation in imparting truth, for there are many who are still incapable of receiving it, and to some it would be like the casting of pearls before swine. Truth must be imparted according to the measure in which men are capable of receiving it and using it rightly. The Christian moralist therefore holds that discoveries and inventions can be justifiably kept secret from those who might use them for evil purposes. A State is within its rights in demanding that secrecy should be observed about inventions made by those whom it has employed when they are intended for its security but might be used by an enemy for its destruction. This secrecy is a temporary expedient due to the evil times in which we live.

The Christian Answer

It is over the application of science to human life that moral problems arise most sharply. The Christian approaches them with the conviction that every individual is of value. He is not alone in this conviction. Many who are not Christians hold it equally strongly ; but the Christian conviction is founded on the belief that God Who is Love has made man in His image, so that He can love man and man can love God. Man is of value, for he is of divine origin and destined for eternity. It was natural, therefore, that Christ should have branded contempt as one of the gravest of sins, for who are we to treat as fools or worthless those whom God loves ? If once the value of the individual is discarded, the way is thrown open to the theories of race superiority which divide mankind into master and slave races. These were carried to their logical extremity by the Nazis in their hideous massacre of all who had Semitic blood, by their enslaving of non-Aryans, and by their liquidation of those who through feebleness of mind or weakness of body were likely to become a burden to the State.

All who believe in the value of the individual are therefore bound to ask of any discovery or invention whether it will heighten life or destroy it. But life to the Christian means far more than physical life, for man has a soul as well as a body, and the physical side of his personality must not be developed at the cost of the spiritual. The Christian, therefore, must always ask whether a new discovery can be so applied as to enrich the whole of man.

Nuclear Warfare

Tested by this standard, all methods of mass destruction, whether by obliteration bombing, by nuclear weapons, by gas, or by bacteriological warfare, are condemned, for they destroy as worthless flies those whom God loves and has made in His own image. Their special wrongfulness lies in the contemptuous and indiscriminate destruction they bring upon masses of men, regardless of whether they are combatants or non-combatants, or of sex or age. The total abolition of war and its causes must be the ultimate goal. To reach it will be a long and difficult journey. But as in the past certain methods of warfare were successfully banned as contrary both to natural and divine law, so in our century it should be possible for the world of nations to discover means by which indiscriminate destruction could be outlawed. No one nation can do this in isolation, for if it threw down its most effective weapons of defence it would only excite attack from its rivals who had remained fully armed. Unilateral action of this nature on the part of a nation might secure for it some physical safety, but at the risk of losing its soul, for if it should come under the totalitarian yoke, its citizens would soon lose all that makes a full life possible, for man has a soul as well as a body, and "what shall it profit a man if he loses his soul ?"

The terrible dilemma between refusing to make these weapons and thus endangering the freedom of a people, or making them and then employing them for appalling destruction, can only be solved by international agreement with effective inspection and drastic sanctions for any breach. All men of goodwill should urge that at the earliest practical moment renewed attempts should be made to forbid the making or the use of these weapons of mass destruction. Until such an effective international agreement is reached the world is threatened with destruction.

Population and Hunger

The same principle of the value of the individual demands that everything possible should be done to preserve life. Once a human being has been born he has the right to live, however lowly or even degrading may be the circumstances of his birth or his social environment. The Indian, the Chinese and the African have the same right to food and health as their more fortunate white brethren. Science has shown how crops can be greatly increased by new methods of agriculture, and how disease can be reduced or banished. But it can do comparatively little unless the more prosperous communities are prepared to make sacrifices for the sake of saving the backward peoples from destitution and starvation. Such sacrifices may mean that the more prosperous nations will have to accept for a time a lower standard of living for themselves.

It is only when food is no longer the chief preoccupation in life and the struggle for bare survival is relaxed that man has leisure to concern himself with the quality of life. Only then will it be possible to educate him into a sense of parental responsibility which will prevent him from bringing into the world more children than he can reasonably hope to support. For however great may be the increase in the food supplies of a country, the growth of population will soon again outpace them if parentage is without foresight, and the birth-rate of backward countries continues to multiply. Side by side with the aid that science can give in the production of food and against disease there must be moral and religious education both in the responsibilities and restraint of parenthood. The quality of life is more important than numbers.

Responsibility of Men of Science

The right use of the discoveries of science depends, therefore, not so much on those who made them as on the moral judgments of the community. Man's inventive genius has grown out of all relation to his sense of moral responsibility. He has advanced in technology, but there has been no corresponding advance in his mastery of himself. He has learnt to work in harmony with the laws of Nature more quickly than he has learnt to live in harmony with his fellow men. He has acquired inventions and tools

long before he has learnt to use them rightly and wisely. So, like Lamech, he has frequently turned to destructive purposes what should have been used for the common welfare. The use or misuse of science depends on the moral judgments of society, and the Christian believes that right moral judgment depends ultimately upon religious faith in the Sovereignty and Righteousness of God.

Men of science have sometimes claimed that when they have made a discovery they have no more responsibility for the use made of it than any other citizen; but in actual fact this is not the case. For they have an influence over contemporary thought and action which is possessed by no other class of men. They are listened to attentively by those who pay little heed to the ecclesiastic, the philosopher or the poet. Often their casual opinions, even on subjects outside their special field, are given reverent attention. They cannot, therefore, say of any of their discoveries, "take them, and use them as you think fit; this is not our responsibility". They must take an active part in educating their fellow countrymen to use rightly the inventions they have given them. They must make plain the terrifying results which may follow the wrong use of some of them. We should be thankful that so many of our leading men of science recognize this responsibility.

We thank God to-day for the love of truth and the unremitting search for it of so many who have given their lives to science. We thank Him for the rich benefits their discoveries so often have brought to mankind; at the same time we must pray that their inventions may be used for life and not for death, for the development of personality and not for its destruction, for the benefit of all and not in the service of greed or the lust for power, for the glory of God and for the good of the human race.

MEASUREMENT OF THE γ-RADIATION FROM THE HUMAN BODY

By Dr. P. R. J. BURCH and Prof. F. W. SPIERS
Department of Medical Physics, University of Leeds

WITH the increasing use of radioactive isotopes in research, industry and medicine, the need has arisen for an apparatus capable of measuring small quantities of these materials which, by accident, may have entered the body. The biological hazards associated with radioactivity are now well known, and it is realized that advance warning by a physical method is necessary if the deposition of radioactive substances in the body is to be kept below agreed maximum permissible levels. The appearance of clinical signs, such as changes in the blood, may occur at too late a stage to be an effective safeguard.

Before the advent of 'artificial' radioactive isotopes, radium, thorium and mesothorium presented the outstanding hazards, and during the past twenty-five years various physical methods for estimating these elements in the body have been attempted. These have included the measurement of radon in the breath and radioactivity excreted in urine and fæces. Apart from the inapplicability of some of these methods, the variability of rate of excretion with time after deposition is often a serious disadvantage, making an estimate of retained radioactivity extremely uncertain.

Direct measurement of the γ-radiation emitted by radioactive elements in the body overcomes many of the ambiguities associated with the sole use of excretion tests. Given a sufficiently sensitive apparatus, it is even possible to detect quite small quantities of energetic β-particle emitters via the bremsstrahlung generated in the body tissues (see Table 2). Early measurements of the γ-ray emission from the body used rather insensitive techniques. Evans[1], with a single Geiger–Müller tube, obtained a lower limit of sensitivity of 100 ng. (1 ng. = 10^{-9} gm.) equivalent radium body content; Hess and McNiff[2], using a single ionization chamber, claimed to be able to detect 15 ng. radium in the body. More recently Sievert[3], using high-pressure ionization chambers, has been able to reduce the standard error to ± 2 ng. with six to eight observations of 2 hr. each made over a period of several months on unexposed individuals, although he points out that there may be systematic errors of the same magnitude. A large high-pressure ionization chamber apparatus has been working for some time in our laboratory[4]. In a single 2-hr. observation the average probable error of measurements on unexposed persons is ± 15 per cent of the normal body radioactivity, equivalent to ± 2 ng. radium. Thus, quite small excesses of radioactivity above the normal can be detected.

The γ-radiation emitted by the body arises principally from the naturally occurring potassium-40 isotope present in body potassium. There may be some districts where the concentration of radium in drinking water leads to body radium burdens giving a γ-ray emission comparable with that from potassium-40[3,5,6]. On the average, the body contains about 0·2 per cent by weight of potassium, and on this account emits some 500 quanta per sec., each of 1·46 MeV. A point source of this strength placed about 40 cm. from an unshielded γ-ray detector in a typical indoor situation would increase the background record by approximately 0·2 per cent. On the other hand, the presence of a human 'source' near the detector will absorb background radiation, and reduce that reaching the detector by at least 2 per cent. It will be seen that the accurate assay of the γ-ray emission from the human body poses problems of considerable difficulty.

On the grounds of stability, reliability and cheapness, high-pressure differential ionization chambers were chosen by us, although it can be shown[4] that an elaborate anti-coincidence arrangement of Geiger–Müller tubes (or, for example, large scintillators with many photomultipliers) should, theoretically, provide a more sensitive performance. In all cases, the degree of resolution of a measurement is mainly a function of the statistical fluctuations of the background.

Only the essential features of the Leeds apparatus will be described here; details of its construction, instrumentation and performance will appear elsewhere. The general layout of the apparatus is illustrated in Fig. 1, and the block diagram of the instrumentation in Fig. 2. The four register ionization chambers are steel cylinders having an effective volume 6·5 ft. long and 11·5 in. in diameter, with ½-in. walls; the subject lies on a couch beneath them. Water shielding surrounds the entire apparatus and reduces the local γ-radiation background to 10 per cent and the total background to just under 50 per cent of the unshielded intensities. Statistical errors

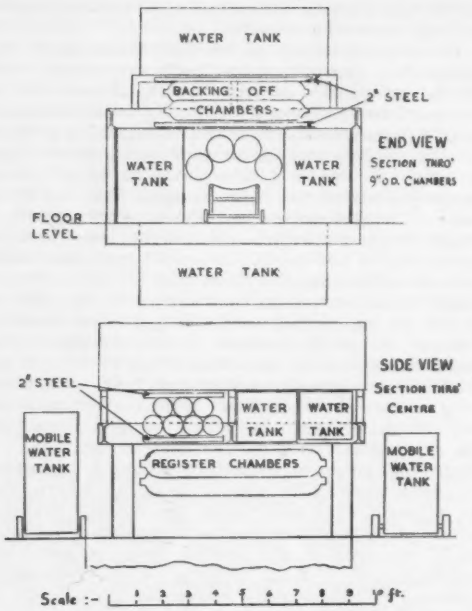


Fig. 1. Body-radiation apparatus. Four recording and seven backing-off chambers. Disposition of shielding at sides and ends of upper chambers is not shown

and the absorption of background radiation by the subject are thereby reduced. Systematic variations in the intensity of cosmic radiation are counteracted by the use of the seven backing-off chambers, and gas pressures are adjusted so that the differential current is unaffected, or only slightly affected by cosmic radiation drifts. Commercial nitrogen has been used and typical working pressures are 13·5 atmospheres in the register chambers and 27 atmospheres in the smaller volume of the backing-off chambers. At these gas pressures, the use of commercial nitrogen (which has a high ionization recombination coefficient) ensures nearly 90 per cent recombination of the ionization along α-tracks arising from traces of radioactive impurities in the chamber walls. Statistical errors from this cause at the low levels of contamination found with these steel chambers then become entirely negligible in comparison with the errors caused by cosmic radiation. The latter produces about 80 per cent of the background ionization and the filtered local γ-radiation nearly all the remaining 20 per cent.

The differential ionization current is amplified by a vibrating-reed electrometer, the output from which is fed into an adapted 'Kent' electro-mechanical recorder, with an automatic averaging device attached to it.

At 4-sec. intervals, the current deflexion on the recorder is automatically converted into pulses which are summed by a scaler. By dividing the integrated deflexion by the number of deflexions recorded, an average current is obtained. Occasionally large bursts of ionization occur in either set of chambers as a result of cosmic ray 'star' events or large showers. The inclusion of these 'anomalous' events could easily lead to erratic averages, so it is arranged that the automatic current-averaging device accepts only those deflexions lying within the range plus or minus twice the standard deviation.

To derive the body radioactivity from the instrument response, corrections must be made for (1) the absorption of background radiation by the subject, and (2) the distribution of the radiation source in the body and the absorption of this internal radiation by the body tissues. The first correction is obtained by measurements with a non-radioactive phantom, a thin sheet-metal container of approximately the shape of the body, filled with distilled water. The ionization produced in the shielded chambers by the normal body radioactivity is still only 0·45 per cent of the residual background, most of which is incident from the vertical hemisphere. A small percentage absorption of cosmic radiation would involve a large correction, and for this reason chambers are disposed only above the subject. As it is, the absorption of background is nearly equivalent and of opposite sign to the emission effect (see Table 1, subject 1). Correction (2) is obtained from the calibration technique. A known quantity (up to 5 μC.) of the 12·5-hr. potassium-42 is administered orally to the subject and the apparatus response determined 4–8 hr. later, during which period the isotope has attained a distribution very similar to that of the normal body potassium. The quantum energies of potassium-42 (1·51 MeV.) and of potassium-40 (1·46 MeV.) are so similar that internal absorption factors are nearly identical for the two radiations. In a previous experiment, the response to a weighed quantity of 'Analar' potassium chloride in a phantom has been compared with the response to a calibrated quantity of potassium-42. From these data the ionization response of the subjects (corrected for background absorption) may be expressed in grams potassium. Although this calibration procedure is only strictly applicable to the potassium content, providing the distribution of any other radioactivity is fairly uniform, a correction may be computed by allowing for differences in attenuation arising between different quantum energies. The total radiation dose received from 5 μC. potassium-42 is 5 mrep., as compared with a typical background dosage-rate of 2·2 mrep. per week.

Measurements have been made on unexposed persons and on others who handle radioactive materials occupationally. Three examples are given in Table 1 to illustrate the component factors in the measurement. Only those occupationally exposed

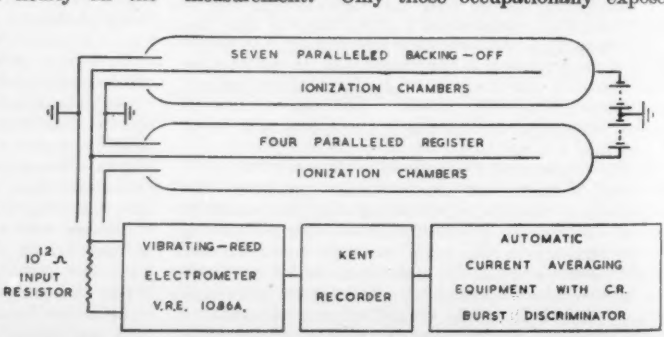

SEVEN PARALLELED BACKING-OFF IONIZATION CHAMBERS
FOUR PARALLELED REGISTER IONIZATION CHAMBERS
$10^{12}\,\Omega$ INPUT RESISTOR
VIBRATING-REED ELECTROMETER V.R.E. 1086A.
KENT RECORDER
AUTOMATIC CURRENT AVERAGING EQUIPMENT WITH C.R. BURST DISCRIMINATOR

Fig. 2

Table 1

1 Subject	2 Body-weight (kgm.)	3* Response above background	4* Background absorption correction	5* Effective response (3 + 4)	6 Activity as equivalent gm. potassium	7 Expected normal potassium content (gm.)	8 Activity above 'normal'
Medical student, male, unexposed	68	1·2 ± 1·2	+ 6·7	7·9 ± 1·2	150 ± 23	143	7 ± 23 gm. potassium
Radiation worker exposed to cobalt-60 dust	55·7	17·7 ± 1·4	+ 6·3	24·0 ± 1·4	413 ± 24	117	= 296 gm. potassium or 15 nC. cobalt-60†
Former mesothorium worker	70·8	79·6 ± 1·2	+ 6·8	86·4 ± 1·2	1,665 ± 23	149	= 1,516 gm. potassium or 0·12 μC. mesothorium

* Units : 10^{-13} amp., for columns 3, 4 and 5. † 1 nC. = 10^{-9} C. = 37 d.p.s.

have so far shown radioactivity significantly in excess of that expected from body potassium. In a group of unexposed persons (ten male and three female medical students resident locally) the mean potassium content, ascribing all the response to potassium-40, was found to be 0·21 ± 0·01 per cent by weight. It is assumed that the water phantom used for background absorption calibration is free from radioactivity. This result is in agreement with that of Shohl[7], who quotes $0{\cdot}21_8$ per cent, based on chemical determinations, and in harmony with recent measurements of 'exchangeable' potassium (said to be approximately 5 per cent less than total) by Edelman *et al.*[8], who find $0{\cdot}18_2$ per cent (average for thirty-three males) and 0·16 per cent (average for fourteen females). All these estimates conflict with the value 0·35 per cent given by Hawk, Oser and Summerson[9].

Table 2 gives the probable error for a single 2-hr. measurement in terms of the body content of a number of commonly used radioactive elements; the maximum permissible levels suggested by the International Commission on Radiological Protection[10] are included for comparison. For γ-ray emitters a quantity much smaller than the maximum permissible level can be detected; but because β-emitters are assayed via bremsstrahlung, the efficiency of their detection is very much reduced.

Table 2

Isotope	Maximum permissible amount in body	Probable error for 2 hr. observation of body activity
Radium-226	100 ng.	2 ng. (for radium in radioactive equilibrium with decay products)
		4 ng. (for 50 per cent excretion of radon in breath)
Thorium-232		2 nC. (or 18 mgm. 'old' thorium)
Mesothorium-1		
Cobalt-60	1,000 nC.	1·4 nC.
Iodine-131	300 nC.	10 nC.
Sodium-24	15,000 nC.	1 nC.
Phosphorus-32 (β-emitter)	10 μC.	2·5 μC.
Strontium-89 (β-emitter)	2 μC.	4 μC.
Strontium-90 (β-emitter) (in equilibrium with yttrium-90)	1 μC.	0·5 μC.

The sensitivity of the apparatus would be much improved in a deep underground laboratory where the cosmic radiation component, responsible for the major part of the statistical fluctuations, would be greatly reduced. Sievert has recently assembled an apparatus in such a situation[11].

This work has been supported throughout by the Medical Research Council, including a maintenance grant to one of us (P. R. J. B.). We are indebted to Messrs. Appleby and Taylor of this Department for technical assistance with the construction and assembly of the apparatus. [June 25.

[1] Evans, R. D., *Amer. J. Roentgenol.*, **37**, 368 (1937).
[2] Hess, V. F., and McNiff, W. T., *Amer. J. Roentgenol.*, **57**, 91 (1947).
[3] Sievert, R. M., *Ark. Fys.*, **3**, 337 (1951).
[4] Burch, P. R. J., Ph.D. Thesis, University of Leeds (1952).
[5] Rajewsky, B., *et al.*, *Strahlentherapie*, **69**, 438 (1941).
[6] Krebs, A. T., *Strahlentherapie*, **72**, 164 (1942).
[7] Shohl, A. T., "Mineral Metabolism" (Amer. Chem. Soc. Mon. Series, Reinhold Pub. Corp., New York, 1939).
[8] Edelman, I. S., *et al.*, *Science*, **115**, 447 (1952).
[9] Hawk, P. B., Oser, B. L., and Summerson, W. H., "Practical Physiological Chemistry" (12th edit., Churchill, London, 1947).
[10] International Commission on Radiological Protection, *Brit. J. Rad.*, **24**, 46 (1951).
[11] Sievert, R. M. (private communication).

DETERMINATION OF TOTAL BODY RADIOACTIVITY USING LIQUID SCINTILLATION DETECTORS

By F. REINES, R. L. SCHUCH, C. L. COWAN, jun., F. B. HARRISON, E. C. ANDERSON and F. N. HAYES

Los Alamos Scientific Laboratory, New Mexico

IN the course of developing equipment for other problems[1], we have made some measurements of the total radioactivity content of several humans and a dog, using a technique which may have other applications in biophysics. The equipment used consists of a liquid scintillation detector in the shape of a cylinder 30 in. in diameter and 30 in. high, surrounded by *RCA* type 5819 photomultipliers, forty-five of which were used in these measurements. Cylindrical steel inserts, 14 in. in diameter in one case and 20 in. in diameter in another, 32 in. high and 0·015 in. thick, were placed in the tank, leaving an annular region filled with liquid scintillator (toluene–terphenyl–α-naphthyl phenyl oxazole). A lead shield 5 in. thick was placed around the assembly, leaving only the top of the insert open. The forty-five photomultipliers were connected in parallel and their output fed through a linear amplifier to a ten-channel pulse-height analyser (see Fig. 1).

Energy calibration. In order to determine the pulse-height corresponding to a given γ-ray energy, a cobalt-60 source was placed in several different locations in the insert and the pulse-height spectra were measured. The results for both inserts are shown in Fig. 2. This spectrum was independent of position of source over the central half of the tank

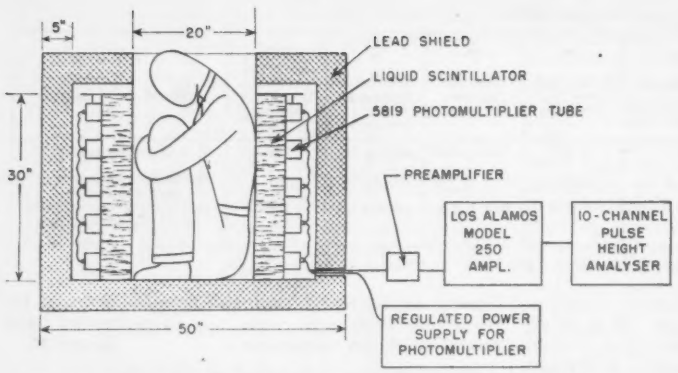


Fig. 1. Sectional view of detector with block diagram of associated electronics

axis. As the source approached the top or bottom, the peak became less well defined. The line represents pulses resulting from the complete Compton degradation of one of the cobalt-60 γ-rays (1·17 and 1·32 MeV. respectively), and the broadening of the high-energy side results from those cases in which both γ-rays are detected simultaneously.

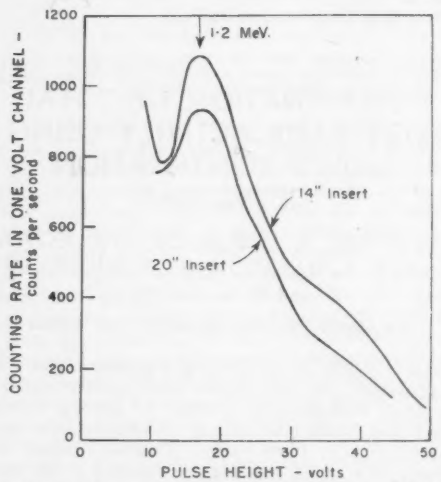


Fig. 2. Counting-rate against pulse height due to a cobalt-60 source placed in the inserts

Data obtained with a dog. A dog of approximately 35 lb. weight was anæsthetized and counted in the small insert. A solution containing 0·1 μC. radium in equilibrium with its decay products was injected in the femoral vein, and (five min. after injection) the dog was again 'counted'. The total counting-rates obtained in the interval 5–35 V., corresponding to 0·3–2·0 MeV., are given in Table 1. The total counting-time for each run was 300 sec.

Table 1. Summary of Results for Experiment on a Dog

Item	Counts per sec.
Background	1,594
Dog before injection, less background	98
0·1 μC. radium solution alone in tank, less background (centrally placed)	1,911
Dog after injection of 0·1 μC. radium, less background	977

From the table it is seen that: (*a*) The counting efficiency per disintegration for the bare source was about 50 per cent. (*b*) The counting-rate from 0·1 μC. of radium in the dog was 879 per sec., giving an overall counting efficiency of about 25 per cent.

Data obtained with humans. The large insert was used for the measurements on humans, who were able by doubling up to be entirely within the insert. The energy gates were the same as in the previous experiment. A background run was made before and after each measurement. The average background counting-rate for twelve runs was 837 ± 6 per sec., and the fluctuations, though greater than statistical, appeared random and consistent with a Gaussian distribution having a standard deviation of 6 sec.$^{-1}$. The fluctuations are presumably due to a slight instability of the discriminator and the rapid rise of background-rate at low energies.

The results of measurements made using various humans are summarized in Table 2. All subjects except 'P. H.' were counted in their normal clothing, and no effort was made to remove radioactive contamination such as might be expected to settle in the hair. The subjects 'W. B.' and 'P. M.' are at present working with radioactive materials; the clothes of 'W. B.' were counted separately, and gave 637 counts per sec. It may be, therefore, that the rather high remaining count was due to external contaminants.

Table 2. Summary of Results for Experiments with Human Beings

Subject	Sex	Weight (lb.)	Counts per sec. above background
'W. L.'	M	130	57
'D. F.'	F	105	30
'W. B.'	M	145	801
'P. M.'	M	160	784
'L. B.'	M	140	42
'E. A.'	M	135	75
'P. H.'	M	140	80
'D. H.'	F	125	57
'G. L.'	F	125	63

Counting efficiency for radium and potassium-40 in humans. The principal natural source of radioactivity in the body is potassium-40. Information on the harmful effects of radioactive isotopes is based principally on persons exposed to radium poisoning. Two experiments were performed to determine the efficiency with which these elements were detected in the counter.

In the first, a mock human form was made by pouring 100 lb. of water into a shaped plastic bag in the insert. The counting-rate was determined before and after the addition of 450 gm. of normal potassium chloride to the water. The net counting-rate from the potassium was 125 sec.$^{-1}$, or 0·52 counts per gm. normal potassium per sec. This number is to be compared with the disintegration-rate[2] of 3·6 γ-rays per gm.-sec., giving an efficiency of 14 per cent. The potassium content of a 70-kgm. person[3] is approximately 150 gm., so the counting-rate expected from potassium alone is about 78 sec.$^{-1}$. It was concluded that most of the activity seen in all subjects except 'W. B.' and 'P. M.' was due to potassium-40.

The efficiency for detecting radium in this counter was determined by counting Dr. Wright Langham ('W. L.') holding a 0·2-μC. standard radium source against his stomach, so that the source was entirely shielded by his body as he sat in the insert. The net counting-rate was 1,133 sec.$^{-1}$, yielding an efficiency of 15 per cent. The statistical fluctuations in the background (± 6 sec.$^{-1}$) correspond to an uncertainty in the total radium of 10^{-9} C. The precision with which it is possible to determine the radium content appears to be limited by the uncertainty in the amount of other radioactive substances present in the body, and by the uncertainty in the degree of elimination of radon, which upsets the radioactive equilibrium of the subsequent daughter products. Most of the gamma-rays detected probably come from radium. It is interesting that, although one of the subjects ('P. H.') has worked for many years with radium, thorium and mesothorium, his radium content appears to be not greater than about 0·01 μC.

Conclusions. In view of the foregoing, it is possible with a counter of this design to determine the total radium content of the body at levels well below the present set tolerance (0·1 μC.), and to make similar determinations for any source giving sufficiently energetic γ-rays. In the absence of the radium group, the potassium content of the body can be measured with good accuracy, and it is quite conceivable that application of these techniques could yield important results in the study of the role of potassium in the metabolic process. These measurements can be made in short times *in vivo* with little inconvenience to the subject.

Since this counter was not designed specifically for the purpose of the present experiment, it should be possible to simplify and improve the system for this type of measurement. For example, the ten-channel analyser could be replaced by a single-channel analyser, or perhaps merely a scaler with a discriminator. Where good energy resolution is not an important factor, it would probably be possible to use many fewer photomultiplier tubes without serious loss of counting-rate. The size of the detector could be increased considerably to accommodate the subjects more comfortably. If smaller animals are to be counted, the counter size and number of tubes could be reduced. Such a counter is being built at this laboratory for studies on dogs.

The background due to cosmic rays was by no means negligible, and would be reduced materially either by additional shielding or by going to sea-level from the altitude of 7,300 ft. at which these experiments were carried out.

It might be possible to reduce background further without seriously impairing the efficiency of detection for the radiation of interest by a more judicious choice of the energy gates.

The superiority of the counter described here over Geiger counters is marked by its high efficiency, energy discrimination for γ-rays, and relatively large volume.

This work was done under the auspices of the United States Atomic Energy Commission. Our thanks are due to Dr. Wright Langham for stimulating conversations and for his generous support.

[May 20.

[1] Cowan, jun., C. L., Reines, F., Harrison, F. B., Anderson, E. C., and Hayes, F. N., *Phys. Rev.*, **90**, 493 (1953).
[2] Nat. Bur. Stand. Circ. No. 499 (Sept. 1950).
[3] Shohl, Alfred T., "Mineral Metabolism" (Reinhold Pub. Corp., New York, 1939).

OBITUARIES

Prof. H. E. Fierz-David

SCIENCE in Switzerland has sustained a great loss in the death on August 25, at Zurich, of Prof. Hans Eduard Fierz-David. Born at Zurich on January 5, 1882, Fierz-David began his education in his native city, eventually specializing in chemistry and prosecuting further studies in London and Munich. In the earlier part of his career he obtained a varied experience of applied chemistry, in particular with the International Nickel Company, also in brewing chemistry, and somewhat later with the firm of J. R. Geigy at Basle. Eventually he developed a special interest in synthetic dyes and the technology of dyes, dyeing processes, and textile fibres. Thus, in 1917 he was appointed to the chair of organic chemical technology, in the Eidgenössische Technische Hochschule, Zurich—a post which he filled with distinction over a long period, until his retirement as emeritus professor. His field of work is reflected in a series of standard publications, including "Grundlegende Operationen der Farbenchemie", "Künstliche organische Farbstoffe", "Fortschritte der Teerfarben und verwandter Industriezweige", and (with E. Merian) "Abriss der chemischen Technologie der Textilfasern".

A cultured man of wide interests, Fierz-David had an international outlook. He was a good linguist, and he cherished the humanistic aspect of his science. This last feature of his character found effective expression in the elegant historical study of alchemy and chemistry which he published at Basle in 1945 under the title, "Die Entwicklungsgeschichte der Chemie". Significantly, he dedicated this book to his friend, C. G. Jung; for among his varied interests he was a member of the Psychological Club of Zurich. Although an apostle of progress in chemistry and its applications, he deplored the methods of 'mass-production' and the intense specialization to which students are subjected in many modern teaching laboratories. Moreover, he recognized the enormous importance of a human relationship between teachers and students. Looking back to his own student-days, in a letter written a few years ago, he crystallized his feelings for a past order of things into a single sentence: "In this age, one has forgotten how to live".

JOHN READ

Mr. W. N. Croft

WILLIAM NOBLE CROFT, who died on July 10 in his thirty-eighth year, joined the Geological Department of the British Museum (Natural History) as palæobotanist early in 1939, and almost at once set off on a British–Swedish–Norwegian Expedition to Spitsbergen, mainly to investigate Devonian fossils, reaching England again just after the Second World War broke out. Before joining the Royal Engineers, Croft completed a paper on a Lower Devonian flora of the Welsh borderland, though his stratigraphical work on this area is still unpublished. Immediately on leaving the army, he went to the Antarctic for a year as geologist and palæontologist to the Falkland Islands Dependencies Survey; some of the results of this work have recently been published in the Survey's "Scientific Reports". In palæobotany, Croft's main interest centred on Devonian plants; last year he published an account of some Devonian charophytes known as trochiliscs, and he had almost completed a paper on blue-green algæ from the Rhynie chert. He was an accomplished technician,

and his room was full of strange gadgets of his own devising, including a sewing-machine converted into a microscope and a bacon-slicer adapted to rock-cutting. The Croft parallel grinding apparatus is in use in many palæontological laboratories. His colleagues will greatly miss not only his judgment and his insistence on the highest standards in everything he touched, but also his singularly attractive charm of manner. W. N. Edwards

We regret to announce the following deaths:

Prof. H. M. Hallsworth, C.B.E., first Dale professor of economics in the University of Durham.

Dr. B. Mouat Jones, lately vice-chancellor of the University of Leeds, on September 11, aged seventy.

Mr. A. Marcan, formerly government chemist and chief assayer in Siam, aged sixty-nine.

NEWS and VIEWS

H. Kamerlingh Onnes (1853–1926)

Heike Kamerlingh Onnes, "le gentleman du zéro absolu", was born at Groningen in Holland a century ago, on September 21, 1853. After studying mathematics and physics at the local university, he went to Heidelberg in 1871 to work under R. W. Bunsen and G. R. Kirchhoff. Eight years later he obtained his degree at Groningen with a thesis entitled "New Proofs of the Rotation of the Earth about an Axis". In 1882, at the age of twenty-nine, he was appointed professor of experimental physics and meteorology at Leyden, where he afterwards established the Cryogenic Laboratory which was destined to become famous throughout the world. Under the influence of J. D. van der Waals, Kamerlingh Onnes studied the equations of state and the general thermodynamic properties of liquids and gases. A pioneer of exact physical measurements at low temperatures, his name is associated particularly with the liquefaction of helium in 1908 and with the discovery of the phenomenon of superconductivity. He was a great organizer possessed of infinite patience, and a master of experimental technique, and he trained a staff which included glass-blowers, skilled mechanics and scientific workers from all parts of the world. Kamerlingh Onnes received the Nobel Prize for Physics in 1913 and the Rumford Medal of the Royal Society in 1912. He was elected foreign member of the Royal Society in 1916, honorary fellow of the Chemical Society in 1920, and corresponding member of the Prussian Academy in 1923. During the First World War and during the early post-war years he devoted himself whole-heartedly to relief work in Europe. Modest, genial, cheerful and universally beloved, he died on February 21, 1926.

Earthquake in Western Cyprus

On September 10, at about 6 a.m. local time, an earthquake occurred with epicentre slightly north of Paphos in Cyprus. The shock, which was registered at Edinburgh, was slightly less intense than the most important of the recent earthquakes in the islands in the Ionian Sea, but nevertheless it caused severe damage and casualties. Three villages, Kithasi, Stroumbi and Ayios Nikolaos, were almost completely destroyed and some 135 other villages within a twenty-mile radius from Ktima were seriously damaged. Much damage was done in Paphos, and the electricity supply and other public services were interrupted. About forty persons were killed and more than a hundred severely injured. Some of the casualties were taken to the hospital at Limassol, where the earthquake was also felt. About fifteen hundred people are known to be homeless as a result of the earthquake. Limassol was shaken by a slight earthquake last year; but the greatest of the recent past earthquakes in Cyprus happened on January 20, 1941. According to the International Seismological Summary, produced at Kew, the epicentre was at lat. 35·2° N., long. 33·6° E., which is just north-east of Nicosia. This shock, according to J. P. Rothé, of Strasbourg, was felt with intensity IX at Paralimni, thirteen miles from Famagusta (see also *Nature*, 148, 145 and 174 (1941); and 149, 640 (1942)). The depth of focus may have been 100 km. Shocks have occurred at other times from epicentres near Nicosia, near Limassol and at sea to the south of Paphos. Other epicentres have been at sea east of Cyprus (between Cyprus and Latakia). The line of past epicentres appears to stretch from Alexandria in Egypt to Nicosia in Cyprus and then to bend to the east, so that the present epicentre is somewhat north-west of this line.

Fifth British Mathematical Colloquium, Durham, 1953

The fifth British Mathematical Colloquium was held in Durham during September 8–10. Members were accommodated in University College and Hatfield College, and the main lectures were given in the Applebey Lecture Theatre of the recently opened Science Buildings. Analysis, topology and differential geometry, number theory and algebra were each given one day, the programmes being: September 8: J. L. B. Cooper, "Critical Point Methods of Functional Analysis"; J. D. Weston, "Convolution Algebras"; H. R. Pitt, "Convergence of Fourier Series"; September 9: J. H. C. Whitehead, "The Elements of Homotopy Theory"; M. G. Barratt, "The Calculation of Homotopy Groups"; A. H. Stone, "Coverings of Topological Spaces"; A. G. Walker, "Differential Geometry in the Large"; September 10: K. Mahler, "The Formal Approximation of Analytic Functions by Rational Functions"; E. M. Wright, "Problems about Prime Numbers"; R. A. Rankin, "The Minkowski–Hajós Theorem on Linear Forms and the Factorisation of Abelian Groups"; R. Rado, "Existence Combinatorics—Order in Chaos". In addition, 'splinter groups' displayed much enthusiasm in afternoon discussions of recent research topics in algebra, analysis, algebraic and differential geometry, topology and number theory. The stimulus of talks and debates on present-day activities in mathematical research was felt by all members of the Colloquium. The sixth Colloquium is to be held at Cambridge in April 1954.

Forests, Catchment Areas and Water Supplies throughout the World

Under the title of "Forests, Catchment Areas and Water Supplies" (*Indian Forest Records* (New Series), Silviculture, **7**, No. 4, 258; 1952), a series of articles by Prof. E. P. Stebbing has been reprinted

that originally appeared in a number of issues of the *Indian Forester* of the preceding months. The publication brings together information received in reply to a questionnaire sent out by Prof. Stebbing to forest services throughout the world, apart from Western Europe, and is prefaced by an introductory review covering sixteen pages setting out the reasons why the compilation was undertaken. This introduction aims at bringing out the need for fuller statistical information as a step towards fuller national and world recognition of urgently needed soil and water conservation measures, with particular reference to the part played by a forest cover; it collects useful and interesting data from scattered sources and reveals the critical situation which has been allowed to arise in the majority of countries. In the second part the statistical details given country by country and catchment by catchment can be of little interest except locally; but the descriptive notes of the history and present situation of forest denudation are often illuminating and of more general value. The publication should provide the conservationist with much useful ammunition in his campaign for public action in this vital field of water supplies.

Science at Christ's Hospital

THE recent celebration of the four hundredth anniversary of Christ's Hospital is marked by the publication of a quatercentenary number of the School's *Science Journal and N.H.S. Report*. This issue contains several articles having a historic flavour. M. Seakins writes of science four hundred years ago, that is, at the time that the School was founded. After referring to the scientific views of Paracelsus (who died twelve years before the signing of the charter of Christ's Hospital), the author deals in an interesting manner with other sixteenth-century pillars of science—chemists, physicists and biologists (who at that time devoted most of their attention to medicine). The founding of the Royal Mathematical School in 1673 is described by T. Dee. The proposal for such a School was originally made by Sir Robert Clayton and the idea was strongly supported by Pepys, whose work for naval education and reform is well known. The School, with a strong body of governors, was established within the framework of Christ's Hospital, and to-day it still provides places in Christ's Hospital for sons of naval officers. T. W. Hoskins, an Old Boy of Christ's Hospital, contributes an article showing how science, through the agency of the anatomist Prof. William Wright, and in collaboration with the historian Mr. Laurence Tanner, in 1933, tackled the problem of the identification of bones supposed to be those of the Princes in the Tower. Their findings are now well known to anthropologists and historians.

Other articles which assist in raising this school journal to a very high level of achievement include: "The Cutting of Gems" by A. E. Rouse; "Modern Weed Killers" by R. G. Hornung; "The Measurement of Strain" by D. J. Kluth; "Counting Butterflies" by M. G. Morris and C. J. Nunn; "Careers in Science and Engineering: (I) Royal Electrical and Mechanical Engineers" by Lieut. J. H. Tomkins (an Old Boy); "Evolution of Colour Photography" by C. L. Hicks; and "An Introduction to Diesel Engines" by N. S. Blake. Also included are the reports of the Entomological, Astronomical, Fishing and Bird Sections of the School's Natural History Society together with reports of other activities of that Society. Christ's Hospital, and especially the editor, J. M. Tims, are to be congratulated not only on this quatercentenary number of its *Science Journal* but also on the serious and successful part that science plays in the School's activities as revealed by the *Journal*.

Excavations at Mycenæ

A SUMMARY by Prof. A. J. B. Wace of his season of excavation last summer at Mycenæ, the most important city of Greece in the Late Bronze Age, has been published in the *Proceedings of the American Philosophical Society* (**97**, No. 3, 248; 1953). As is his habit, Prof. Wace has produced not only useful data for the specialists, but also more startling discoveries. Of these, there are a fine ivory facing, carved with a pair of griffins and originally half a metre or more in length; a terra-cotta figurine of a man riding a horse, which shows that, after all, the Mycenæan Greeks used horses for riding as well as drawing chariots; and thirty-eight clay tablets inscribed in the so-called Linear *B* script. These tablets, the first collection to be found at Mycenæ and the first from a private house anywhere in Greece, have turned up most opportunely, since it seems that at last the script is being deciphered. But too much should not be expected from their decipherment; it will show what language the Mycenæans spoke, but the texts may well give no more than inventories of stores or the like. Prof. Wace is continuing his excavation this season.

Arctic Aerobiology

QUANTITATIVE and qualitative studies of the fungi in the air over various parts of Alaska and Canada are reported by S. M. Pady and L. Kapica (*Canad. J. Bot.*, **31**, 3, 309; 1953). In winter, arctic air is apparently sterile; in summer, at Ft. Churchill, Man., ground-level samples varied from 0·5 to 4·4 per cu. ft. *Cladosporium* was the commonest fungus (average 0·5 per cu. ft.), followed by yeasts (0·16), *Penicillium* (0·06), and *Stemphylium* (0·03 per cu. ft.). Other fungi present were *Pullularia*, *Botrytis*, *Aspergillus*, *Verticillium*, *Pyrenochæte*, *Helminthosporium*, *Phyllosticta*, *Papularia*, *Cunninghamella* and *Sporormia*. Of 3,711 colonies, 57 per cent failed to sporulate. Silicone slide readings as high as 114·9 fungus spores per cu. ft. were obtained and included the following: yeasts (8·6), *Cladosporium* (3·8), smuts (2·5), *Fusarium* (0·6), *Alternaria* (0·06 per cu. ft.), *Venturia*, *Cercospora*, *Septoria*, rusts, *Leptosphæria*, *Sordaria* and *Pleospora*, and many hyaline one-celled spores. In two flights to Resolute Bay, N.W.T., the flora was found to be similar to that at Ft. Churchill, but numbers did not exceed 1 per cu. ft. although readings up to 78 fungus spores per cu. ft. were recorded on slides in warm air over Hudson Bay. Most of the fungi are considered to be soil types originating in agricultural areas and carried northward by southerly winds. The majority are no longer viable when they reach the arctic. There is evidence that the numbers of fungi are correlated with air masses, not only in the arctic but also in air over other parts of Canada.

Coryndon Memorial Museum, Nairobi: Report for 1952

THE annual report for 1952 of the Coryndon Memorial Museum, Nairobi (pp. 26; 1953; 1*s*.), though referring to the set-backs due to Mau Mau activities, also records the opening of a new wing. This important addition contains five new

large exhibition halls which have been allocated respectively to botany; insects and allied forms; marine and freshwater biology and reptiles; geology, minerals and palæontology; and man. The new wing also contains a machine shop, a spirit room and extensive storage accommodation. Another interesting development at this well-known and progressive museum is that a loan was raised by the Government for the erection of a block of four flats. The flats are rented to members of the staff, and it is planned to repay interest and capital on the loan in twenty years.

Orientation of the Orbital Planes of Visual Binaries

Certain conclusions are deduced by A. Opolski, of the Stockholm Observatory, with respect to the orbital planes of binaries on the basis of the distribution of slow-moving physical pairs with different apparent separations of components, and these conclusions are described in a paper entitled "Orientation of the Orbital Planes of the Visual Binaries" (*Arkiv för Astronomi*, **1**, No. 18; 1952). Very briefly, the method is as follows. If we compare two slow-moving binaries, each of the brighter components having the same spectral type and the same apparent magnitude, and differing only in the apparent separation s of the components, it is very probable that such a pair of systems will have, on the average, equal absolute magnitudes, equal masses and equal distances from the sun. The difference in s in these circumstances is chiefly due to the difference in the inclinations i of their orbital planes. For obvious reasons, when s is small i is large—probably approaching 90°—and when s is large i is small—approaching 0°. All this is explicable because of the effect of perspective shortening, and for this reason there should be a correlation between s and i in groups of physical pairs with known dynamical parallaxes and with similar spectral types and apparent magnitudes. To obtain some idea of the validity of this assumption, all slow-moving physical pairs with their known trigonometric or spectroscopic parallaxes listed by Russell and Moore are dealt with. These stars are grouped according to spectral types and apparent magnitudes of brighter components and are arranged in each group according to s. Each group is then divided into three parts, each of which contains nearly the same number of stars, and two limiting values of separation s_1 and s_2 (s_1 being greater than s_2) are determined so that stars with separation $s > s_1$ form group i with small inclination, $s_1 > s > s_2$ form group ii, and $s_2 > s$ form group iii with large inclination. Numerical values of s_1 and s_2 are found in this way, and a comparison is made between the trigonometrical and dynamical parallaxes for stars belonging to groups i and iii. The stars selected for this purpose have their trigonometrical parallaxes t within the limits $0{\cdot}100'' > t \geqslant 0{\cdot}025''$, and the difference between the two mean values of dynamical parallaxes corresponding to the same mean trigonometrical parallaxes is very pronounced. This can be explained only by the systematic difference in inclination of the orbital planes of stars belonging to the groups i and iii, and substantiates Opolski's assumption.

Geographical Exploration To-day

The Department of Extra Mural Studies of the University of London is arranging a series of twelve weekly illustrated lectures on "Geographical Exploration To-day", to be given in the Lecture Theatre, University College Medical School, London, W.C.1, on successive Wednesdays at 6.30 p.m., commencing September 30. The subjects to be dealt with and the respective lecturers are as follows: general introduction, by Prof. F. Debenham; arctic exploration, by J. M. Scott; antarctic exploration, by J. M. Wordie; exploration of the ocean depths, by Dr. G. E. R. Deacon; exploration in Central Africa, by Prof. F. Debenham; exploration in Ceylon, by B. H. Farmer; North-East Land, by Dr. K. S. Sandford; Cambridge Jontunheim expedition, by W. Vaughan Lewis; team-work in Colonial territories, by A. T. Grove; modern navigation by sea and air, by W. L. Harrison; exploring and climbing mountains, by J. H. Emlyn Jones; and exploring the past, by Prof. W. G. East. The fee for the course is 15*s.*; tickets for single lectures (obtainable at the lecture room on the occasion of each lecture) are 2*s.* Applications for admission tickets should be addressed to the Cashier, University of London, Senate House, Malet Street, W.C.1, and marked 'Extension courses'.

Announcements

Dr. D. W. Adamson, head of the Chemical Division of the Wellcome Research Laboratories, Beckenham, has been appointed research director of the Wellcome Foundation, Ltd., and director of the Wellcome Research Laboratories, in succession to Dr. J. W. Trevan, who has retired after thirty-three years of service with the company. Dr. Adamson has also been appointed to the board of the Wellcome Foundation, Ltd.

In his Pedler Lecture, "The Life and Times of Sir Richard Gregory, Bt., F.R.S., 1864–1952" (*Nature*, June 13, p. 1040), Sir Harold Hartley remarked that the Elihu Root Lecture given by Sir Richard Gregory at the Carnegie Institution of Washington and entitled "Cultural Contacts of Science" "is unknown in his own country". The substance of this Lecture was published in *Nature*, **142**, 1059 (1938), and we are now informed by the Carnegie Institution that a limited number of copies of the Lecture are available free of charge.

The British Institute of Recorded Sound, Ltd., in conjunction with the University of London, Department of Extra Mural Studies, is arranging a course of twelve lecture-recitals illustrating various uses of sound-recordings in the study of music, drama, literature and science. The three lectures with a bearing on scientific themes will be as follows: October 21, the sounds of wild animals and birds, by Ludwig Koch; January 13, folk music, by Frank Howes; and February 10, recording dialects and folklore, by David Abercrombie. All twelve lectures will be given on Wednesdays at fortnightly intervals, starting on October 7, at the Institut Français, Queensberry Place, London, S.W.7. The fee for the course is £1 (2*s.* 6*d.* a single lecture). All inquiries and applications should be made by post to the Honorary Secretary, British Institute of Recorded Sound, 36 Redcliffe Close, Old Brompton Road, London, S.W.5.

Erratum. In a letter on "Hæmoglobin in Protozoa" (*Nature*, Sept. 5, p. 451, col. 1) the sentence beginning on line 13 from the bottom should read: "Aerated suspensions of *Tetrahymena* showed a weak but distinct α-band of oxyhæmoglobin at about 582 mμ and a less distinct β-band at about 545 mμ which was somewhat masked by the absorption bands of cytochrome".

MEDIUM-ENERGY NUCLEAR PHYSICS

CONFERENCE AT THE UNIVERSITY OF PITTSBURGH

DURING June last, the University of Pittsburgh sponsored a second conference on medium-energy nuclear physics similar to that held in 1952. There were five sessions of invited papers intermingled with discussions. The first dealt with beta-decay, the second with nuclear forces and capture gamma-rays, the third with photon-induced reactions, the fourth with inelastic neutron scattering and nuclear energy-levels, and the final one with neutron-induced reactions.

The first paper, by L. Langer (Indiana University), discussed the evidence for a unique beta-interaction which can explain all known features of beta-decay. This includes the shape of the allowed and forbidden spectra, selection rules, the radium-*E* spectrum, and angular correlations between the emitted electron and the recoil nucleus. It seems likely that a linear combination of scalar, tensor, and perhaps some pseudoscalar can account for all known effects. In the second paper, M. E. Rose (Oak Ridge National Laboratory) indicated that even theoretically there are deviations from straight-line Kurie plots to be expected other than those due to Fierz interference. He suggested an experiment, the angular correlation in the $^{14}O \rightarrow {}^{14}N^*$ decay, which would definitely fix the nature of the Fermi-type interaction. In the third paper of the session, H. Primakoff (Washington University in St. Louis) reviewed the experimental evidence of Fulbright and McCarthy, and of Ingram and Reynolds for the existence and half-life of nuclei undergoing double beta-decay. The observed half-lives of zirconium-96 (10^{16} yr.) and of tellurium-120 (10^{21} yr.) make the effect difficult to detect. The theoretical estimates of such half-lives depend on the assumption of the existence of an anti-neutrino distinct from the neutrino or on the opposite assumption. The theoretical estimate is also difficult to make, but it appears that the no anti-neutrino hypothesis fits better. The decay of the μ-meson may be able to clarify the question.

The second session was opened by I. Talmi (Princeton University), who showed how the empirical rule that in even–even nuclei the spins and parities of excited states are either both odd or both even can be understood. It is necessary to use the fact that the potential is short-range, but then the result follows in both the Russell-Saunders and *j*–*j* coupling limits. The second paper was a review of the Butler theory of stripping reactions by E. Gerjuoy (University of Pittsburgh). This theory has been of great service in discovering the spin and parity of many nuclear-levels. It is not, however, in complete agreement with observed angular distributions. Arbitrariness in fitting the distribution could be reduced by comparing experimental and theoretical absolute differential cross-sections. However, the method of making allowance for Coulomb interactions is not at all clear. In the third paper, E. B. Paul (Chalk River Laboratory) spoke of his work on gamma-rays following proton capture. This work was done with the Chalk River electrostatic accelerator. The observed intensities of various gamma-rays of the same multiple order do not seem to accord with present theoretical expectations. The final paper of the session was a report by G. Bartholomew (Chalk River Laboratory) on work by B. B. Kinsey and himself with neutron captive gamma-rays. In particular, he discussed the great intensity of electric dipole radiation when the states were such as to permit it. Strong transitions to states other than the ground-state were found, where the information was sufficient, to be electric dipole.

The third session was opened by V. Telegdi (University of Chicago). He gave an account of the operation of isotopic spin selection rules in reactions induced by photons. The threshold energy of certain reactions, notably (γ,α) reactions, shows the operation of the conservation of total isotopic spin law. His experiments have been carried out with photographic plates. The other paper of this session was given by L. Katz (University of Saskatchewan). He reported on his work on reactions induced by photons from a betatron. In particular, he has studied neutron production, and has obtained indications of nuclear-levels by breaks in the yield-curve of neutrons as a function of photon energy.

The first three papers of the fourth session were devoted to inelastic neutron scattering. J. Beyster (Los Alamos Scientific Laboratory) described the spherical shell method for measuring inelastic neutron cross-sections. H. A. Bethe (Cornell University) discussed the interpretation of such experiments at energies where elastic scattering is large and nearly isotropic. The difficulty lies in the increased path-length in the shell due to elastic scattering. Methods for allowing for this which give values for inelastic scattering independent of experimental geometry were described. The resulting cross-sections vary as the geometrical cross-section except in the cases of the so-called magic nuclei, where they are smaller. T. Bonner (Rice Institute) described sphere measurements at higher neutron energies where the elastic scattering corrections are unimportant. The cross-sections turn out to be in good agreement with the geometrical cross-section except for the magic nuclei lead and bismuth, which are 10 per cent low. At low energy (~ 3 MeV.) the cross-sections are less than the geometrical. R. Hellens (Westinghouse Electric Corp.) described some neutron scattering experiments on iron using photographic plates. F. Ajzenberg (Massachusetts Institute of Technology) closed the session with a comprehensive review of the energy-levels of light nuclei with especial emphasis on charge symmetry and charge independence of nuclear forces.

The last session was opened by H. Feshbach (Massachusetts Institute of Technology). He showed how the concept of the nuclear radius is at present ambiguous. Electron scattering, isotope shift, and μ-meson decay all measure the average electrostatic potential in the nucleus and all give results corresponding to a nuclear radius of $1{\cdot}2 \times 10^{-13} A^{1/3}$ cm. The binding energies of mirror nuclei, also affected by Coulomb forces, give $1{\cdot}45 \times 10^{-13} A^{1/3}$ cm. At present this cannot be reconciled. Next H. Barschall (University of Wisconsin) described the results of his work on the scattering of neutrons of heavy elements. The dependence of the cross-section for scattering on the incident energy and on the mass number has been determined over a wide range of these variables. This variation can be interpreted, as V. F. Weisskopf (Massachusetts Institute of Technology) explained in the next paper, on the 'cloudy crystal ball' model of

the nucleus. The nucleus is represented by a potential with an imaginary part which represents absorption of the neutron. Adjustment of the depth, the radius (which is assumed to vary as $A^{1/3}$) and the absorption enables a very good fit to be obtained over the entire range of energy and mass. It may be possible to interpret the absorption in terms of the formation of a compound nucleus. The last paper was by C. Goodman (Massachusetts Institute of Technology), who presented some evidence of nuclear excitation by the electrostatic field of an incident proton.

PHILIP STEHLE

AMERICAN AID FOR SCIENTIFIC AND INDUSTRIAL RESEARCH IN GREAT BRITAIN

FURTHER details of the proposed expenditure on advisory service, research and on education and training of the Counterpart Funds derived from United States Economic Aid under the Mutual Security Act of 1952, originally outlined in Cmd. 8776 of February 25, 1953, are given in a White Paper dated July 1953 (Programme of Expenditure of Counterpart Funds derived from United States Economic Aid. Cmd. 8918. Pp. 8. H.M.S.O. 4*d*. net). Under "Advisory Service", £25,000 goes to the Department of Scientific and Industrial Research for the development of advisory services in industrial engineering, and in the use of measurement techniques developed in the National Physical Laboratory, and a further £125,000 for assistance to research associations (in conjunction with trade associations where suitable) for the development or initiation of advisory services. A number of trade and employers' associations will receive grants totalling £72,000 in all to enable them to employ consultants on such subjects as cost accounting, factory lay-out and organization and the deployment of labour. The Ministry of Works receives £20,000 for the development of the Building Advisory Service, and the Ministry of Labour and National Service £15,000 for assistance to voluntary organizations developing advisory services to industry in the field of training. Agricultural departments will receive £116,500 for the extension or initiation of specific advisory services, and the British Institute of Management £35,000 for research and the preparation and provision of information of management subjects of importance to productivity and for the extension of the Institute's information and research departments.

Of £589,500 provisionally allocated for research, £210,000 goes to a programme of economic research based in part on proposals put forward by universities and research organizations. It includes £42,000 for studies of general factors affecting productivity and the adoption of innovations; £100,000 for studies in monopoly, competition and restrictive practices, including studies in the structure of selected industries; £25,000 for studies in the growth of capital and the finance of industry; £8,000 for studies of economic problems affecting labour recruitment and mobility; £11,000 for studies in economic problems of transport and £19,000 for studies in the statistical measurement of production. The programme of research in production economics, for which £75,000 is allocated, will be carried out under the ægis of the Department of Scientific and Industrial Research by research associations and other bodies. It will include studies of the innovation and development of new ideas; of the flow of scientific and technical information to industry and its relation to innovation and industrial efficiency; of the economics of re-equipment; and of the measurement of productivity and the causes of variation of industrial efficiency.

The programme of social research, for which £190,000 is allocated, will be planned and co-ordinated by the two Committees on Human Relations in Industry and Industrial Efficiency recently set up by the Lord President of the Council. It includes £20,000 for studies of the influence of equipment design and working conditions on the efficiency of operators; £15,000 for studies of factors affecting the efficient utilization of industrial engineering techniques; £30,000 for studies of factors influencing the effectiveness of incentive payment schemes; and £40,000 for studies of those restricting and facilitating the introduction of new production techniques and methods in industry; £30,000 for studies of the characteristics of management organizations influencing productivity; £10,000 for studies of factors facilitating the efficient utilization of university graduates in industry; and £25,000 for studies of promotion and training in industry. The allocation of £114,500 for research in agricultural subjects includes £8,000 each for studies in land ownership and in land economics; £25,000 for a survey of prevalence, etc., of livestock diseases, and £22,500 for studies of egg- and table-poultry production.

Of the £519,000 provisionally allocated for education and training, £290,000 is for the endowment of three university chairs or readerships in engineering and related subjects. It is hoped that one in heavy electrical engineering and another in production engineering will be at the Imperial College of Science and Technology, London. The £130,000 for technical education is for the creation of teaching posts in industrial engineering and the provision of scholarships in methods of engineering, work study and personnel management. Of £68,000 to agricultural departments, £25,000 is for postgraduate scholarships and a like sum for managerial and special courses for staffs of Co-operatives, £18,000 is for assistance to Scottish crofters, £20,000 is provided towards the development of engineering training facilities at Queen's University, Belfast, and the Belfast College of Technology, and £6,000 to the Department of Scientific and Industrial Research towards technical and management training in the cast iron industry.

The allocation for publicity includes £22,400 for publications, chiefly to the Department of Scientific and Industrial Research for the preparation of technical digests of articles appearing in the technical press, and the preparation of brochures on technical information services; and to research associations for the preparation of technical publications. An allocation is also being made to the Ministry of Works for the preparation of technical publications giving the results of scientific research and new developments in building. One million pounds has been allocated to the Revolving Loan Fund, £700,000 for loans to industry and £300,000 for loans to agriculture; advisory committees have been set up for each part of the fund. The types of loan likely to be approved and the conditions which will be attached to them will be announced by the committee for industry, of which Sir John Woods is chairman. Loans to agriculture (of which committee Sir Stanford Cooper is chairman) will be confined in the first instance to

two main purposes: the provision of part of the approved capital cost of acquisition and installation of grain-drying equipment and storage facilities; and assistance in the provision of plant, equipment and working capital for agricultural co-operative societies and other approved associations of farmers.

AMERICAN PHILOSOPHICAL SOCIETY

YEAR BOOK FOR 1952

THE year book for 1952 of the American Philosophical Society* includes a brief history of the Society and a copy of the charter, together with the list of members and the customary obituary notices and list of publications during the year; besides this it gives, in the report of the committee on research, lists of grants made during the year January 1–December 31, 1952, from the three research funds administered by the Society as follows: from the Penrose Fund, which is unrestricted, 133 grants totalling 123,250 dollars; from the Johnson Fund, nine grants totalling 20,687 dollars; and from the Daland Fund, which is limited to research in clinical medicine, three grants totalling 3,750 dollars. Brief reports from recipients of grants, arranged alphabetically by sciences, are also included. Among the longer of these summaries may be mentioned those of the following: M. D. Taylor on the vapour-phase dissociation of formic, propionic and acetic acids, indicating that formic acid possesses by far the weakest hydrogen bond, acetic and propionic acids possessing bonds of nearly equal strength; R. W. Chaney, comparing the Cenozoic floras of Japan with those of corresponding age in North America, and indicating that *Metasequoia* was widely distributed and abundant at high northern latitudes during Cretaceous and Tertiary time; H. P. Hansen on his investigation of post-glacial forest migrations and climate in western Canada and Alaska by means of pollen analysis of peat sections; R. J. Drake on a study of the species (and distribution) of the non-marine mollusc fauna of Sonora (Mexico); W. B. Jackson on microclimatic factors in army ant behaviour and ecology; and A. Loveridge on ecological studies on the vanishing fauna of rain-forest remnants in tropical East Africa. F. A. McDermott reports further data on Jamaican Lampyridæ, M. C. Carlsen on plant collecting in southern Mexico and Honduras, H. A. Imshaug on a taxonomic and phytogeographic study of the lichen flora of the Rocky Mountains, Hui-Lin Li on a study of the Scrophulariaceæ of China, H. E. Moore, jun., on native and cultivated palms of the western hemisphere, and H. T. Skinner on character patterns in the American azaleas.

K. J. Hayes records an analysis of chimpanzee intelligence, and in biochemistry J. L. and E. M. Irvin report on their spectrophotometric study of the interaction of quinoline and acridine derivatives with plasma proteins, nucleic acids and nucleoproteins. W. J. Eversole summarizes studies which indicate a physiological role of secretions of the adrenal medullary hormones in water and electrolyte metabolism; G. R. Seaman, metabolic studies on the growth factor protogen; L. S. Crossman, studies on the prehistory of the Oregon coast; and M. I. Hilger, an ethnological field study of the beliefs, customs and traditions in the development, rearing and training of the Araucanian Indian child of Chile. Besides E. M. Kampa's investigation of the photosensitive pigments in marine animals in the vicinity of Bermuda, which indicates the observation of at least one new photosensitive pigment, there are briefer reports on eight other investigations by scientists working at the Bermuda Biological Station for Research, including aspects of phosphate metabolism, the luminous bacteria–bacteriophage system, the metabolic effects of sinus gland removal in land Crustacea, the sponges of Bermuda, cell-growth and development as affected by changes in oxidation-reduction potential, and parasitological studies of fishes.

* American Philosophical Society. Year Book, 1952. January 1, 1952–December 31, 1952. Pp. 486+1 plate. (From the Society, Philadelphia, Penn., 1953.)

STANDARD FREQUENCY TRANSMISSIONS FROM THE UNITED KINGDOM

STANDARDS of frequency and time differ from other standards of measurement in that they can be made available continuously over wide areas by means of radio transmissions. The frequencies of 2·5, 5, 10, 15, 20 and 25 Mc./s. have, by international agreement, been allocated for this purpose; and for several years past, a continuous service on all these frequencies (and also on 30 and 35 Mc./s.) has been operating from station *WWV* of the National Bureau of Standards, near Washington, D.C.

Such transmissions enable the user to standardize his equipment without costly and elaborate apparatus, but to be fully effective they must be received in all parts of the world. The *WWV* transmissions do not meet this requirement, and experiments on an international scale are therefore being conducted under the general direction of the International Radio Consultative Committee in order to discover the best means of securing world-wide coverage.

As the United Kingdom's contribution to this work, a limited programme of transmissions has been made daily since February 1950 from the Post Office station at Rugby under the call-sign *MSF*. On May 26 this year the programme was extended to provide a continuous (twenty-four hours a day) service of transmissions on the three frequencies of 2·5, 5 and 10 Mc./s. Later, 15 and 20 Mc./s. may be used, but only three frequencies will be transmitted simultaneously. The signals are identified by a speech announcement made at fifteen-minute intervals, while during five-minute periods the carrier waves are modulated in turn by a 1,000-c./s. tone and by 1-c./s. pulses, the fifty-ninth pulse in each minute being omitted. A supplementary local service for use within the United Kingdom is also provided by a special transmission at a frequency of 60 kc./s. for a period of one hour daily.

Full details of these new transmissions are given in a pamphlet issued by the National Physical Laboratory, Teddington, under the title "*MSF*—New Programme of Experimental Frequency Transmissions from the United Kingdom". The carrier and modulation frequencies are all obtained from the same standard and are maintained within ± 2 parts in 10^9 of their nominal values. The transmissions are regularly monitored at the National Physical Laboratory, and the results of daily measurements on

60 kc./s. are published monthly in the *Wireless Engineer*. Although the absolute frequency cannot be determined with certainty to better than one part in 10^8, relative values are known to one part in 10^9; and as the day-to-day stability is of interest to some users, the results are published to this accuracy.

These transmissions from the United Kingdom are interrupted during the interval 15–20 minutes past each hour so that one station alone can be measured under conditions where, for example, the signals from two stations such as *MSF* and *WWV* are being received at nearly equal strengths. This break in transmission will also permit measurements of radio noise to be made if no other transmission is present.

JOHN HENRY NEWMAN AND SCIENCE

DURING 1852 J. H. Newman delivered a series of lectures in University College, Dublin, which were known as "Discourses on the Scope and Nature of University Education". They are now usually read, as finally published in 1873, under the title of "The Idea of a University Defined and Illustrated". Newman founded the University College and was its first principal for some years. Opinions differ concerning the value of his work in Ireland—even Shane Leslie thought that it was a failure—but a series of lectures, given a century after Newman's endeavours to put before the Irish his ideas concerning the aims and functions of a university, were delivered by leading members of the staff of the institution which he founded and helped to create.

Prof. T. S. Wheeler* has dealt systematically and with commendable objectivity with Newman's views on the place of science in a university. Although Newman regarded the teaching of science and professional subjects as a duty of a university, nevertheless he considered the development of the mind the primary end of university education. His object was to form, particularly in his junior students, a cultivated intellect on which other knowledge could be grafted. Although Newman insisted that he had been fighting liberalism all his life, he intended his objections to concern the liberalism which was more recently known as rationalism or scientific humanism. He was a champion of a liberal education in the modern sense. A 'gentleman' was one who had been improved and sensitized by such an education (but even in his day Newman was not the only antagonist of the more partial of Locke's educational theories). Newman insisted that it is only the mind trained and developed by a liberal culture that can profitably absorb and utilize knowledge of all kinds. On one hand, we have to distrust the view that the liberally educated man can control everything—"a view that has flowered to its greatest exuberance in the Civil Service" (and is occasionally found in modern universities). On the other hand, we have to face the dangers which arise from over-specialization. Since Newman wrote, science has developed at an enormous rate. About a million scientific papers are published each year, and the scientist is overwhelmed by a flood of knowledge. As a result, there is more and more pressure of material for inclusion in a university course and an increasing tendency to specialization. The point of view of the average science graduate is narrow: neither at school nor at the university does he receive the training which Newman regarded as fundamental, except in rare cases. There is an increasing complaint that scientists know more and more about less and less, and that they are not always able to express themselves clearly by mouth and pen. If this is true, the disease is more apparent than the remedy; but it is satisfactory to note that in England most schools are trying to do something to overcome the intellectual narrowness of both their science and their arts students; and, if little has yet been done, the universities are at least aware of the needs.

Prof. Wheeler comments as follows: "In Newman's view the great object of a university is to make something or other of its students and not simply to protect the interests and advance the dominion of science. The modern estimate of the place of research in a university department of science is completely at variance with that of Newman; though he tended to modify these views later in life. At present, discovery is regarded as more important than teaching, and the standing of a science department is determined by the quality of the research work it produces rather than by the quality of its teaching. The plums in the academic profession go to the research worker. The good teacher seldom reaches the top". (In the modern university there is, of course, the 'good organizer' whose abilities and qualifications it is extremely difficult to define.)

Surprisingly, Newman was alive to the need for the development of teaching applied science in his University. The Great Exhibition of 1851 had shown that British industry was losing its premier place owing to the manner in which Continental nations were fostering applied science. The teaching of engineering, agriculture and medicine involves a practical as well as an academic approach and yet these subjects have been successfully incorporated in a university discipline.

Since the 'thirties of this century we have had theories, in spate, of the aims and nature of a university: we have had Allison Peers in "Red Brick", Moberly in "Post-War Crisis", the Harvard Report, Goodhart and Livingstone from an old university, Colonial and international conferences, the 'synthetics' of the Anglo-American peripatetics, and so on. In the midst of all this there is still something of relevance in the elegant writings of Newman.

W. L. Sumner

* "Newman and Science." By Prof. T. S. Wheeler. *Studies*. An Irish Quarterly Review. (The Talbot Press, Dublin, Summer 1953.)

STRUCTURAL BASIS OF THE CROSS-STRIATIONS IN MUSCLE

By Dr. JEAN HANSON* and Dr. HUGH E. HUXLEY†

Department of Biology, Massachusetts Institute of Technology, Cambridge, Massachusetts

THE myofibrils of striated muscle consist largely of protein (more than 90 per cent of their dry weight)[1], and it is believed[2] that the only proteins present in significant quantities are myosin, actin and probably a small amount of tropomyosin. We shall describe here evidence that the cross-striation of the

* Fellow of the Rockefeller Foundation. On leave from the Medical Research Council Biophysics Research Unit, King's College, Strand, London, W.C.2.

† Fellow of the Commonwealth Fund. On leave from the Medical Research Council Unit for the Study of the Molecular Structure of Biological Systems, Cavendish Laboratory, Cambridge.

myofibrils results from a discontinuous distribution of myosin along their length, the myosin being confined to the *A*-bands. Previous authors have tentatively suggested that this may be the case[3-6], but we believe that our evidence is more direct and conclusive than any previously presented.

Methods have become available during recent years for extracting successively myosin and actin from muscle, with very little mutual contamination; minced fresh muscle in the form of broken fibres is used as the starting material. We have examined this material microscopically (in phase-contrast illumination, in polarized light and in the electron microscope) at various stages of extraction. We have also modified the procedures to permit their use on isolated myofibrils, where the whole process of extraction can be observed visually on the same single myofibril.

If minced rabbit muscle, before any extraction, is examined either by using normal histological sectioning procedures or else by fixing the material in formalin and fragmenting it to myofibrils in a Waring blendor, then the normal band pattern of relaxed muscle is seen. If, however, the muscle is examined after extraction for twenty minutes either by Guba–Straub solution (0·3 *M* KCl, 0·15 *M* phosphate buffer, *p*H 6·5) or by Hasselbach–Schneider[7] solution (0·47 *M* KCl, 0·01 *M* pyrophosphate, 0·1 *M* phosphate buffer, *p*H 6·4), then a new band pattern is seen. The *A*-band has largely disappeared, leaving only a narrow dark line which in favourable circumstances may be resolved into two fine lines lying on either side of the original *H*-band; the sarcomere-length is unchanged. Apart from the narrow dark band and the *Z*-line, the sarcomeres now have uniformly low density along their whole length and their birefringence has become very small or zero (cf. the *I*-band in normal muscle).

If the Hasselbach–Schneider procedure[7] for actin extraction is now carried out (the residue from the myosin extraction being broken up in a Waring blendor and stirred for eighteen hours with 0·6 *M* potassium chloride, *p*H > 6·0), the organized structure of the muscle disappears and only debris remains. Similarly, few fibrils can be recognized in the residue left after the use of Hasselbach and Schneider's method[7] for the simultaneous extraction of actin and myosin.

In order to observe these processes more closely, we have developed methods for carrying out analogous extractions on isolated myofibrils. Two types of fibrils were used: some were prepared by a modification of the method of Schick and Hass[8] ('trypsin-prepared fibrils') and others by breaking up bundles of glycerinated fibres[2] in a Waring blendor. A drop of a suspension of myofibrils is placed on a slide under a coverslip and observed in phase-contrast illumination or polarized light. Material from the *A*-band ('*A*-substance') is then removed from such myofibrils by irrigating the preparations with the following solutions: (1) Hasselbach–Schneider pyrophosphate solution plus 1×10^{-3} *M* $MgCl_2$; (2) Guba–Straub solution plus 4×10^{-4} *M* ATP. The *A*-substance disappears in 1–2 sec., leaving a fibril 'ghost', consisting of a faint 'backbone' with *Z*-lines and with a pair of lines on either side of each original *H*-band (Fig. 1); the fibrils are no longer distinguishably birefringent and, in contrast to their behaviour before extraction, they will no longer contract in 4×10^{-4} *M* ATP in 0·1 *M* KCl, 10^{-3} *M* $MgCl_2$. The loss of *A*-substance is accompanied by some swelling of the

Fig. 1. Trypsin-prepared fibril under phase-contrast microscope, (*a*) before and (*b*) after extraction of *A*-substance by Guba–Straub–ATP

fibrils: if myofibrils are treated with Guba–Straub solution alone without ATP or with Hasselbach–Schneider's solution without magnesium, then swelling still occurs, but this time it is not accompanied by loss of *A*-substance or loss of birefringence.

In the case of trypsin-prepared myofibrils, a slower secondary extraction process seems to occur, and the fibril ghosts become progressively fainter with longer treatment; if the extraction is carried out in a test-tube, then the ghosts apparently break up and dissolve, and no recognizable fragments can be recovered. It seems that these fibrils are unstable once the *A*-substance has been removed, and that any mechanical agitation will destroy them. This would account for the ease with which Hasselbach and Schneider[7] can extract actin when the residue from the myosin extraction is broken up in a Waring blendor. In the case of the glycerinated myofibrils, however, the ghosts are stable and may be recovered by centrifugation after a test-tube extraction. Examination of the supernatant in a Beckman ultra-violet spectrophotometer supports the view that protein-like material passes into solution during this extraction.

We have examined the 'ghost' fibrils in the electron microscope and compared them with normal fibrils. In the first instance this was done on unstained and unshadowed preparations, and it was found that the density distribution apparent under phase-contrast illumination in the light microscope was closely paralleled by that seen in the electron microscope. For more detailed examination, a thin-sectioning procedure was used; this technique has been described by Hodge, Huxley and Spiro[9] in a study of various types of intact muscle; the microtome used was that described by the same authors[10]. In these studies on intact muscle a hexagonal array of filaments about 100 A. in diameter was seen in the *A*-band, together with a good deal of interstitial

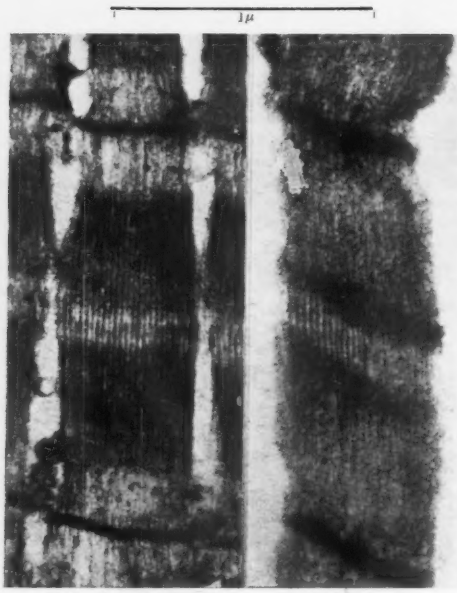


Fig. 2. Electron micrographs of thin sections through (*a*) intact glycerinated fibril and (*b*) glycerinated fibril after removal of *A*-substance by Guba-Straub-ATP

material. The *I*-band appeared to have been preserved less satisfactorily; it was much less dense than the *A*-band and contained much thinner filaments. Later studies by one of us (Huxley[11]) have shown that the interstitial material in the *A*-band itself consists of filaments, about 30–40 A. in diameter, and that in the absence of ATP these filaments are arranged in a regular six-fold array around each of the larger filaments. These observations confirmed the earlier predictions from low-angle X-ray diffraction studies[12]. It was also observed that the secondary six-fold array was absent from the *H*-band, where the diameter of the thicker filaments was about 130 A.

We find that, after extraction of the *A*-substance from isolated myofibrils by the methods described above, the thicker filaments which formed the primary array are no longer visible in the *A*-band, and that only fine filaments can now be seen; in the *H*-band, however, the thicker filaments are still present. The *Z*-lines and the thin dense bands on either side of the *H*-band are also visible (Fig. 2).

To summarize, we believe that the following evidence suggests very strongly that myosin is primarily concentrated in the *A*-bands in muscle and that it is responsible for the high density and the birefringence of these zones, and that actin is present as long filaments which extend continuously through *A*- and *I*-bands.

(*a*) Extraction procedures which are known to remove myosin and little or no actin from whole muscle remove a large amount of material from the *A*-band, and leave it with a low density and birefringence like that of the original *I*-band.

(*b*) If such extraction procedures are followed by the removal of actin, then the remainder of the organized structure of the muscle disappears, leaving only debris.

(*c*) If extraction procedures similar to those used to remove myosin from whole muscle are carried out on myofibrils, then the *A*-substance is removed, and the extraction can be viewed in a single myofibril in phase-contrast illumination or in polarized light. The material which passes into solution can be demonstrated to be protein-like by spectrophotometry.

(*d*) If such extraction procedures (carried out on trypsin-prepared myofibrils) are followed by mechanical agitation, then the fibril ghosts pass into solution.

(*e*) The *A*-bands of intact muscle, as seen in the electron-microscope, contain two sets of filaments. The larger filaments appear to have a total volume three to four times that of the smaller filaments: this is consistent with the view that the larger filaments are composed of myosin and the smaller ones of actin. After extraction of the *A*-substance, the larger filaments disappear.

We do not consider that observations of a shortening of the *I*-band during contraction necessarily imply that both actin and myosin are present there: such observations cannot at present distinguish between a genuine shortening of the filaments in the *A*-band, a migration of *A*-substance into the *I*-band, or a retraction of *I*-band filaments into the *A*-band.

In its simplest form, our picture of muscle is as follows: thin filaments of actin extend from the *Z*-line through the *I*-band and through one half of the *A*-band, until they join up with the *H*-band filaments, the composition of which is unknown. Myosin is located primarily in the *A*-band, in the form of filaments about 100 A. in diameter, which extend from the *A*–*I* junction up to the *H*-band, where they too join up with the *H*-band filaments. The myosin filaments are arranged in a continuous hexagonal array across the fibrils, with the actin filaments lying between them; in the absence of ATP, the actin filaments are linked to the myosin and form a regular six-fold array around each myosin filament. If the actin–myosin link is broken by the presence of ATP or pyrophosphate, the myosin filaments may be dissolved out from the muscle by solutions of suitable ionic strength, leaving behind a structure principally composed of actin.

We are at present pursuing experiments, similar to those described above, on muscle at various stages of contraction, in order to relate this concept of its structure to the mechanism of contraction.

We are greatly indebted to Prof. Francis O. Schmitt for the encouragement he has given to this research, and to the Rockefeller Foundation and the Commonwealth Fund for their support.

[1] Perry, S. V., *Biochem. J.*, **48**, 257 (1951); **51**, 495 (1952); *Biochim. Biophys. Acta*, **8**, 499 (1952).
[2] Weber, H. H., and Portzehl, H., "Advances in Protein Chemistry", **7**, 161 (1952).
[3] Szent-Györgyi, A., "Chemistry of Muscular Contraction" (2nd edit., Academic Press, New York, 1951).
[4] von Muralt, A. L., and Edsall, J. T., *J. Biol. Chem.*, **89**, 351 (1930). Weber, H. H., *Ergebn. Physiol.*, **36**, 109 (1934).
[5] Amberson, W. R., Smith, R. D., Himmelfarb, S., Stout, C., and Hoch, H., *Biol. Bull. Woods Hole*, **99**, 314 (1950).
[6] Ashley, C. A., Porter, K. R., Philpott, D. E., and Hass, G. M., *J. Exp. Med.*, **94**, 9 (1951).
[7] Hasselbach, W., and Schneider, G., *Biochem. Z.*, **321**, 461 (1951).
[8] Schick, A. F., and Hass, G. M., *J. Exp. Med.*, **91**, 655 (1950).
[9] Hodge, A. J., Huxley, H. E., and Spiro, D. (in the press).
[10] Hodge, A. J., Huxley, H. E., and Spiro, D. (in the press).
[11] Huxley, H. E. (in preparation).
[12] Huxley, H. E., Faraday Soc. Symp., "Size and Shape Factor in Colloidal Systems" (1951); *Proc. Roy. Soc.*, B, **141**, 59 (1953).

EVIDENCE OF HARMONICS IN THE SPECTRUM OF A SOLAR RADIO OUTBURST

By J. P. WILD, J. D. MURRAY and W. C. ROWE
Division of Radiophysics, Commonwealth Scientific and Industrial Research Organization, Australia

THE spectrum of the high-intensity radiation emitted by the disturbed sun at metre wavelengths is being investigated over a wide, continuous frequency-range extending from 38 to 220 Mc./s. The principle of the instrument follows that of an earlier model[1], but the extended frequency-range is achieved by using three swept-frequency receivers covering adjacent bands which are switched into operation in quick succession. Complete spectra are obtained every half-second and photographed on continuously moving film.

On November 21, 1952, at 23h. 50m. U.T., an outburst of radio noise from the sun was recorded on the instrument. The disturbance was accompanied by two flares both starting at 23h. 45m. (one of Importance 3, maximum at 23h. 50m. at 7° W., 6° N.; the other, Importance 2, 23h. 58m., 3° E., 6° N.), a magnetic disturbance, a short-wave communication fade-out, and a sudden diminishing of cosmic noise at frequencies up to about 70 Mc./s. The latter was registered on our record at 23h. 48·4m. and provides an accurate timing of the arrival of ultra-violet radiation relative to the outburst. (The information about the flares was received from Dr. M. Notuki, Tokyo Astronomical Observatory, and that on the magnetic disturbance from Mr. R. F. Thyer, Bureau of Mineral Resources, Melbourne.)

The dynamic spectrum is shown in Fig. 1*a*, in which intensity is indicated by two contour-levels as a function of frequency and time. At any instant the high-level radiation is received only in two widely spaced frequency bands, both of which exhibit the characteristic[2] frequency-drift from high to low frequencies. For much of the time each main band is split into two well-defined peaks of which the band-width, Δf, between half-power points may be as low as 2 Mc./s. When plotted on a logarithmic frequency-scale, as in Fig. 1*a*, the two main bands show a marked similarity in their general features and the two patterns appear to be essentially parallel. Thus the *ratio* of the frequencies of corresponding features in the two bands tends to remain constant. Corresponding features usually appear and disappear almost simultaneously. In view of their close correspondence, there seems little doubt that the two bands are due to the same source of emission.

The ratio between the frequencies of corresponding peaks lies mainly in the range 1·90–1·99, and in no case exceeds 2·00. For narrow band peaks ($\Delta f/f < 0{\cdot}05$) the ratio lies between 1·96 and 1·99; for broader peaks the ratio may be lower. Fig. 1*b* shows that if the frequency of a peak in the upper band is halved, the resulting point lies on the low-frequency slope of the corresponding peak in the lower band.

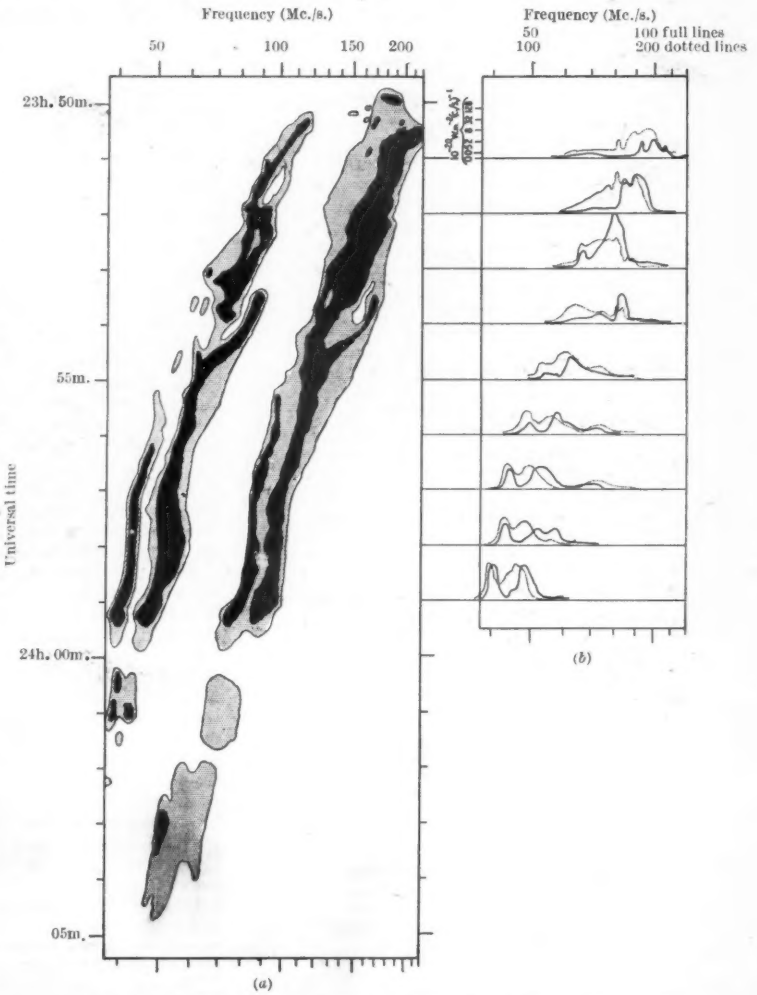


Fig. 1. (*a*) The calibrated dynamic spectrum of the outburst. The contours show intensity as a function of frequency and time and correspond to levels of approximately 5 and 20×10^{-21} W. m.$^{-2}$ (c./s.)$^{-1}$ (one plane-polarized component). (*b*) Profiles at one-minute intervals. The higher frequency band in (*a*) is shown dotted and displaced in frequency by a factor of two

The closeness of the ratio to 2 suggests that the two main bands are harmonically related. If this is so, two observed characteristics require explanation: (1) that the ratio is consistently slightly below 2·00; and (2) that the intensity of the presumed second harmonic is comparable with, or greater than, that of the fundamental, whereas the third harmonic, if radiated, must have been at least ten times weaker than the second.

The existence of a well-defined lowest frequency ('cut-off'), established by earlier observations of outburst spectra[2], led to the adoption of the hypothesis that the cut-off corresponds to the lowest frequency of escape at the level of the source in the solar corona, and that the frequency-drift corresponds to a movement of the source outwards through the corona. Neglecting magnetic fields, the 'lowest frequency of escape' from a source near the centre of the sun's disk is approximately equal to the natural plasma frequency[2], f_0. The occurrence of a sharp peak near the cut-off was associated with some kind of resonance phenomenon taking place near the f_0-level. If now we suppose that emission takes place at harmonic frequencies $f_0, 2f_0, \ldots$, in descending order of strength, the second and higher harmonics will reach the earth almost unattenuated, whereas frequencies close to f_0 will suffer highly selective absorption in their passage through the corona[3] (see Fig. 2). The rapid increase in absorption as the frequency is reduced through f_0 causes not only a diminishing of the peak-intensity but also a displacement of the peak-frequency by up to half a band-width. The close agreement between the result of this simple argument and the observed spectrum gives support to the conclusions (1) that the two main bands are harmonically related, and (2) that the radiation originates at the f_0-level.

The occurrence of multiple peaks within each main band could be due either to a multiple source or to splitting by magnetic fields. Taking the extreme low-frequency edge to indicate the height of the source, Fig. 3 shows the calculated variation of height with time. The heights are derived using a conversion table published by Smerd[4], based on the Baumbach–Allen distribution of electrons in the corona.

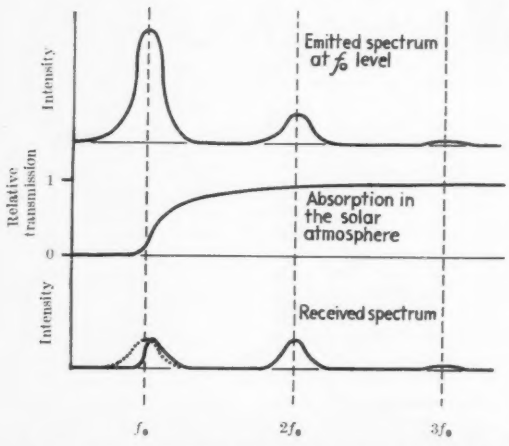


Fig. 2. Illustrating the effect of absorption in the solar atmosphere on harmonics emitted from the f_0-level. In the lowest curve, the second harmonic is reproduced with two-to-one frequency shift (dotted line)

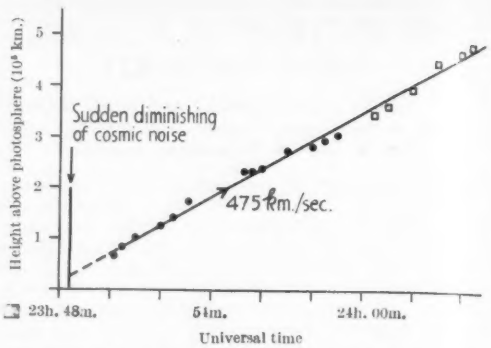


Fig. 3. Variation with time of the height of the source of the outburst according to the hypothesis described in the text. Where possible, heights are derived from the cut-off frequency of the lower band (**black dots**). The range is extended to greater heights by using half the frequency of the upper band (squares)

Apart from local deviations the gradient is constant throughout the curve, and corresponds to a velocity of 475 km./sec. It is of interest to note that if the constant-velocity line is produced towards the origin, the whole phenomenon could be explained in terms of a constant-velocity source ejected at the start of the ultra-violet emission from a region near the base of the corona, about $2{\cdot}5 \times 10^4$ km. above the photosphere.

The deduced velocity of 475 km./sec. agrees with previous values similarly derived[2], but the present data extend over a much wider range and give a clear indication that no acceleration occurred as the source moved outwards. Hence a real discrepancy exists between the derived velocity and the mean velocity (800–1,600 km./sec.) of the particles responsible for generating great magnetic storms on the earth, with which the source of outbursts has been tentatively identified[2]. Furthermore, Payne-Scott and Little[5] have derived velocities of 1,000–3,000 km./sec. from directional observations on outbursts. The discrepancy may be explained if, as suggested by recent evidence of Machin and Smith[6], the solar corona becomes much more extended than the Baumbach–Allen model for particular times and directions. It would disappear if the height scale in this model were increased by a factor of two to three.

[Feb. 10.

Note added in proof, August 11. The evidence presented above has recently been confirmed by a second outburst recorded on May 5, 1953, at about 5h. U.T. The spectrum showed two narrow bands which drifted in the usual way. The ratio of the peak frequencies lay in the range 1·93–2·00. No third harmonic was detected. The ratio of the peak intensities of the lower to the upper frequency bands varied between $\frac{1}{4}$ and 10.

Outbursts showing the characteristic spectrum but no detectable harmonic have been recorded on two occasions since observations were started in August 1952.

[1] Wild, J. P., and McCready, L. L., *Aust. J. Sci. Res.*, A, **3**, 387 (1950).
[2] Wild, J. P., *Aust. J. Sci. Res.*, A, **3**, 399 (1950).
[3] Jaeger, J. C., and Westfold, K. C., *Aust. J. Sci. Res.*, A, **3**, 376 (1950).
[4] Smerd, S. F., *Proc. Inst. Elect. Eng.*, Pt. III, **97**, 447 (1950).
[5] Payne-Scott, Ruby, and Little, A. G., *Aust. J. Sci. Res.*, A, **5**, 32 (1952).
[6] Machin, K. E., and Smith, F. G., *Nature*, **170**, 319 (1952).

A MACROSCOPIC THEORY OF INTERFERENCE AND DIFFRACTION OF LIGHT FROM FINITE SOURCES

By Dr. E. WOLF

Department of Mathematical Physics, University of Edinburgh

IN the usual treatment of interference and diffraction of light, the source is assumed to be of vanishingly small dimensions (a point source), emitting strictly coherent radiation. Such a treatment corresponds essentially to an idealized wave field, created by a (classical) oscillator.

The important advances made in optics in recent years, in particular the discovery of phase contrast by Zernike[1] and of the method of reconstructed wave-fronts by Gabor[2], make it highly desirable to formulate a theory of interference and diffraction which applies to fields created by an actual (finite) source.

In papers to be published elsewhere, I propose a macroscopic theory of stationary fields produced by a finite source of natural, nearly monochromatic light. According to this theory, the intensity $I(x)$ in such a field can be expressed to a degree of accuracy sufficient for the purposes of many practical applications, in the form of a generalized Huygens's principle:

$$I(x) = \iint_{\Sigma\Sigma} \Gamma(p_1,p_2)\tau(0,x_1)\tau(x_1,x)\tau^*(0,x_2)\tau^*(x_2,x) \Lambda_1\Lambda_2^*\mathrm{d}\Sigma_1\mathrm{d}\Sigma_2. \quad (1)$$

Here Γ is a factor which characterizes the source, τ is a transmission function which characterizes the optical properties of the medium and Λ is the usual inclination factor of Huygens's principle. The integration is carried out twice independently over an arbitrary surface Σ cutting across the field, the ray vectors p_i ($i = 1, 2$) at the source being related to the position vectors x_i of points on Σ by means of the canonical relations:

$$p_i = \left[\frac{\partial}{\partial\xi} S(\xi, x_i)\right]_{\xi=0}, \quad (2)$$

S being Hamilton's point characteristic function of the medium. The factor Γ is related to the specific intensity $j(\xi)$ across the source σ (assumed to be a radiating plane element) by means of the relation

$$\Gamma(p_1,p_2) = \sqrt{\chi(p_1)\cos\theta_1}\sqrt{\chi(p_2)\cos\theta_2} \int_\sigma j(\xi)\,[\exp ik\{(p_1-p_2).\xi\}]\mathrm{d}\sigma, \quad (3)$$

the terms under the square roots being unessential directional factors, which in practice can usually be replaced by a constant, $k = 2\pi/\lambda$, λ being the wavelength. We normalize Γ, setting

$$\frac{\Gamma(p_1,p_2)}{\sqrt{\Gamma(p_1,p_1)}\sqrt{\Gamma(p_2,p_2)}} = \gamma(p_1-p_2). \quad (4)$$

It is seen that in (1) the properties of the source and the transmission of the medium are completely separated; also, that (1) contains only observable quantities, the non-observable phase factors which are associated with the instantaneous emissions of light having disappeared on taking the time average. Further, it is seen that the intensity distributions produced by different sources the Γ factor of which is the same are identical. This is probably the main reason why in Gabor's remarkable method of reconstructed wave-fronts one can use a different source for the reconstruction from that employed in taking the hologram.

Equations (3) and (4) enable γ to be calculated whenever the specific intensity distribution $j(\xi)$ across the radiating surface is known. It can also be shown that, under fairly general conditions, γ and consequently $j(\xi)$ may be determined from simple experiments.

Equations (1) and (3) make it possible to obtain solutions to a variety of optical problems. Although the theory is developed for radiation in the visible range of the spectrum, it seems probable that it will also apply to electron optics and perhaps also to the optics of X-rays. In the latter it may lead to a fuller interpretation of X-ray diffraction patterns of crystals. In astronomical applications the theory may enable information to be obtained about the distribution of radiation across stellar sources from the study of interference patterns (this question is discussed in forthcoming articles by R. Fürth and E. Finlay-Freundlich, and myself, to be published in "Vistas in Astronomy" (Pergamon Press, London)), a possibility which was recognized many years ago by Michelson[3] and recently pointed out again by Hopkins[4].

In the limiting case, as $\gamma \to 1$, (1) reduces to an expression for the intensity due to an ideal point source. Thus (1) contains the mathematical formulation of practically the whole elementary diffraction theory of optical image formation as a limiting case. It can also be shown that many of the results on partial coherence obtained by earlier authors (Berek[5], Van Cittert[6], Zernike[7], Hopkins[4]) also follow from our generalized formulation of Huygens's principle.

I am indebted to Prof. Max Born for stimulating and helpful discussions. [March 13.

[1] Zernike, F., *Physica*, **9**, 686 (1942).
[2] Gabor, D., *Proc. Roy. Soc.*, A, **197**, 454 (1949); *Proc. Phys. Soc.*, B, **64**, 449 (1951).
[3] Michelson, A. A., *Phil. Mag.*, **30**, 1 (1890); *Astrophys. J.*, **51**, 257 (1920); *Astrophys. J.*, **53**, 249 (1921) (with Pease, P. G.).
[4] Hopkins, H. H., *Proc. Roy. Soc.*, A, **208**, 263 (1951).
[5] Berek, M., *Z. Phys.*, **36**, 675 and 824 (1926); **37**, 387 (1926) **40**, 420 (1926).
[6] Van Cittert, P. H., *Physica*, **1**, 201 (1934).
[7] Zernike, F., *Physica*, **5**, 785 (1938).

SEISMIC REFRACTION EXPERIMENTS IN THE INDIAN OCEAN AND IN THE MEDITERRANEAN SEA

By Dr. T. F. GASKELL and J. C. SWALLOW

Dept. of Geodesy and Geophysics, University of Cambridge

THIS communication completes the preliminary account of results of seismic refraction experiments carried out in H.M.S. *Challenger* during her world cruise of 1950–52. Five stations in the Indian Ocean continue the deep-ocean studies described in two previous publications[1], and nine stations in various parts of the Mediterranean Sea give a measure of local underwater geological structure.

Indian Ocean

Fig. 1 shows the position of seismic stations in the Indian Ocean; Table 1 gives a summary of results.

Table 1

Station	Position	Depth (fm.)	Velocity in upper layer (ft./sec.)	Velocity in deep layer (ft./sec.)	Sediment thickness (ft.)	Upper layer thickness (ft.)
22	8° S. 95½° E.	2,805–2,855 (5·15–5·24 km.)	No upper layer	21,500 ± 500 (6·56 km./sec.)	1,500–2,500 (0·46–0·76 km.)	—
23	5½° S. 91½° E.	2,690–2,705 (4·94–4·96 km.)	16,500 ± 400 (5·03 km./sec.)	19,500 ± 1,000 (5·94 km./sec.)	500–1,800 (0·15–0·55 km.)	5,500 (1·68 km.)
24	4° S. 90° E.	1,655–1,710 (3·04–3·14 km.)	13,700 ± 200 (4·18 km./sec.)		1,200–2,400 (0·37–0·73 km.)	7,000 (2·14 km.)
25	3½° S. 86° E.	2,640–2,655 (4·84–4·87 km.)	14,500 ± 1,200 (4·42 km./sec.)	20,300 ± 1,200 (6·19 km./sec.)	1,800–2,600 (0·55–0·79 km.)	4,500 (1·37 km.)
26	2° S. 85° E.	2,550–2,580 (4·67–4·73 km.)	15,000 (4·57 km./sec.)	21,000 ± 2,000 (6·40 km./sec.)	6,000 (1·83 km.)	4,500 (1·37 km.)

At the Seychelles, a velocity of 7,000–9,000 ft./sec. (2·1–2·7 km./sec.) was found for a 90-ft. layer of coral rock. The velocity in the granite below this was 18,100 ft./sec., increasing to 19,700 ft./sec. (5·51–6·00 km./sec.); the refraction lines were limited to 1½ miles, and no deeper structure was found.

Station 22. This is in deep water outside the trench that lies to the seaward of Java and Sumatra. The structure here is similar to that found in the flat deep areas of the Pacific.

Station 24. This is on the top of a sea mount that rose about 6,000 ft. (1·83 km.) out of a very flat area of ocean bed. This area extended from 6° S. to within a hundred miles of Ceylon, and was flat to within a few fathoms per mile along the track followed by the ship, except for the large sea mount, and for a second small sea mount the sides of which

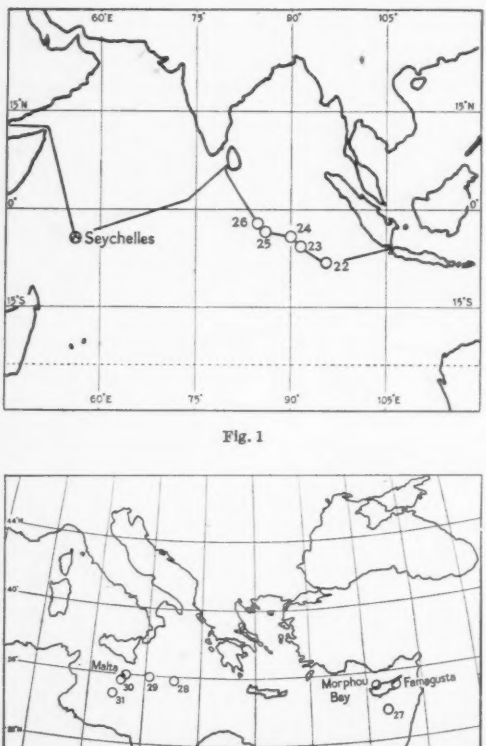


Fig. 1

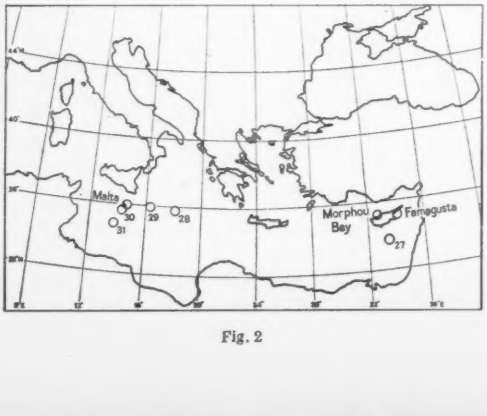


Fig. 2

sloped at about 1 in 5, and the top of which was a few hundred yards across.

The flat ocean area was much greater in extent than any other that had been sounded by the *Challenger*; it sloped upward from 2,700 fathoms (4·94 km.) in the south to 2,300 fathoms (4·21 km.) in the north. It was not possible to see from the echo-sounder record whether this slope was really a series of level steps or whether the average value of 1 in 2,000 was maintained throughout.

The depth over the top of the sea mount was irregular, and the velocity determined for the main constituent material could have been higher than the 13,700 ft./sec. (4·17 km./sec.) given in Table 1. The figure for minimum thickness of the 13,700 ft./sec. layer is calculated assuming that the underlying material has a velocity of sound of 21,000 ft./sec. (6·4 km./sec.). The thickness of sediment is variable, and is dependent on an undetermined velocity of sound, which, for all the Indian Ocean stations, has been taken as 7,000 ft./sec. (2·1 km./sec.).

Stations 23 *and* 25. At these stations a considerable thickness of material with velocities of 14,500–16,500 ft./sec. (4·4–5·0 km./sec.) was interposed between the sediment and the 'deep' layer. The velocity for the deep layer is less than that found at station 22, but if there is continuity of material, then this (4·4–5·0 km./sec.) layer is depressed well below the 3,000-fathom (5·5-km.) level at stations 23 and 25 adjacent to the sea mount; this structure is not unlike that found near Bermuda and, in the Pacific, near volcanic islands. It is possible, however, that north of station 22 the submarine geology is similar to that of the continents. At station 26 the velocity profile was not well determined, but the large part of the 6,000-ft. (1·8-km.) thickness of sediment was made up of a material with velocity 8,000 ft./sec. (2·4 km./sec.). Refraction lines of 30–40 miles (50–65 km.) will be needed to plot the depth of the Mohorovičić discontinuity in the Indian Ocean in order to determine the nature of the area to the north of lat. 6° S.; the present results are sufficient to indicate a difference in structure between north and south.

The Mediterranean Sea

Fig. 2 shows the positions of the nine stations at which measurements were made in the Mediterranean. The locations were chosen to assist the interpretation of gravity measurements made in 1950[2], but bad weather reduced the number of refraction lines possible leaving a rather isolated set of observations. However, the seismic data do suggest some grouping.

Stations 27, 28, 29, 31. All these stations show a single refracted wave the intercept of which corresponds to 1,200 ft. (0·36 km.) of sediment, and in which the velocity is about 14,500 ft./sec. (4·4 km./sec.). The thickness of sediment is calculated at an assumed

Table 2

Station	Position	Depth (fm.)	Depth (km.)	Velocity in upper layer (ft./sec.)	Velocity in upper layer (km./sec.)	Sediment thickness (ft.)	Sediment thickness (km.)
27	34° N. 33½° E.	1,080	1·98	14,300	4·36	1,100	0·33
28	36° N. 18° E.	2,175	3·98	15,000	4·57	1,200	0·37
29	36° N. 16° E.	1,940	3·54	14,500	4·42	1,200	0·37
31	35° N. 14° E.	195	0·36	14,900	4·54	2,600	0·97

value of 7,000 ft./sec. (2·1 km./sec.) except for station 31, where the shallower depth allowed observation of a layer with a velocity of 7,700 ft./sec. (2·3 km./sec.), 1,700 ft. (0·52 km.) thick beneath 900 ft. (0·27 km.) of material with (assumed) velocity of 6,000 ft./sec. (1·8 km./sec.). No layer with higher velocity was indicated by arrivals at nine miles for station 27 and for five to six miles at stations 28, 29 and 31. This could mean that the layer with velocity 14,500 ft./sec. (4·4 km./sec.) is more than 7,000 ft. (2·14 km.) thick at station 27, and more than 2,000 ft. (0·61 km.) thick at stations 28, 29 and 31, if the layer directly beneath has a velocity of 21,000 ft./sec. (6·4 km./sec.). However, the structure might also be a comparatively thin band of material with velocity 14,500 ft./sec. (4·4 km./sec.) underlain by a material with lower velocity; in order to produce a refracted wave at the distances given above, the band would probably have to be several hundred feet thick. (Results in East Anglia and in Persia suggest 100 ft. (0·03 km.) thickness of a limestone band for every 6,000 ft. (1·83 km.) of observable refracted wave.) If this is so, the fact that no refracted wave at 21,000 ft./sec. (6·4 km./sec.) was observed gives a minimum thickness of about 3,000 ft. (0·91 km.) of material with low velocity, beneath the band with velocity 14,500 ft./sec. (4·4 km./sec.) for station 27 and about half this thickness for stations 28, 29 and 31.

Cyprus. A detailed station, in 400 fathoms (0·73 km.), in Famagusta bay showed that a material of velocity 14,400 ft./sec. (4·39 km./sec.) was covered by 1,400 ft. (0·43 km.) of sediment the velocity in which was found to be 5,700–6,800 ft./sec. (1·74–2·07 km./sec.). At about four miles the refracted wave from this layer died out, suggesting that the layer was about 350 ft. (0·10 km.) thick, or that there was a horizontal discontinuity. A deep layer with velocity 22,000 ft./sec. (6·7 km./sec.) was detected 5,000 ft. (1·5 km.) below this, assuming a velocity 8,000 ft./sec. (2·4 km./sec.) between the 350 ft. thick layer and the material with velocity 22,000 ft./sec. If there were a horizontal discontinuity, the top of the 22,000 ft./sec. layer would be about 8,000 ft. (2·4 km.) below the sea surface. The high-velocity layer is several thousand feet, at least, nearer the sea surface than an undetected similar layer at station 27 could be.

At Morphou Bay, on the west side of Cyprus, the topography was very irregular, but some results in a depth of 75–140 fathoms (0·13–0·26 km.) showed that a rather irregular layer with velocity 9,700 ft./sec. (2·96 km./sec.) was covered with 1,900 ft. (0·58 km.) of sediment which had a well-measured velocity of 6,000 ft./sec. (1·8 km./sec.). Some refracted waves, arriving after those from the material with velocity 9,700 ft./sec., suggest that a layer with velocity 13,500 ft./sec. (4·1 km./sec.) lies 4,500–6,500 ft. (1·4–2·0 km.) below the sea-bed.

Malta. A short refraction line in 74 fathoms (0·13 km.) north of Malta (36° N., 14½° E.) showed that 650 ft. (0·2 km.) of sediment, with a measured velocity of 5,440 ft./sec. (1·66 km./sec.), lay on top of material with velocity 11,400 ft./sec. (3·48 km./sec.). The latter would be greater than 2,000 ft. (0·6 km.) thick if it continued solidly to a material with velocity 18,000 ft./sec. (5·5 km./sec.). If it were a thin band underlain by a material with velocity 8,000 ft./sec. (2·4 km./sec.), the total thickness to a basement with a velocity of 21,000 ft./sec. (6·4 km./sec.) could not be less than 1,500 ft. (0·46 km.).

At station 30 (35½° N., 14½° E.) the only refracted waves observed in 420 fathoms were from a material with velocity 18,750 ft./sec. (5·72 km./sec.). This was covered by about 1,200 ft. (0·36 km.) of sediment. The cover material could equally well be 200 ft. (0·06 km.) of sediment with velocity 5,440 ft./sec. (1·66 km./sec.), together with 2,200 ft. (0·67 km.) of material with velocity 11,400 ft./sec. (3·48 km./sec.). Measurements in the laboratory of velocities in limestones collected from Malta show values ranging from 9,300 to 19,000 ft./sec. (2·8–5·8 km./sec.).

The Mediterranean results in general show a more complicated structure than that found in the deep oceans. The existence of thin high-velocity layers is probable, which allows different interpretations of the seismic data. This does not mean that there is unlimited freedom in choosing a geological sequence, and a combination of gravity data and known geology on land may give an unambiguous picture. So far as possible the limiting values have been given in this account.

The fact that deep water obscures refracted waves from the sea-bed sediment layers leads to greater uncertainty in the Mediterranean than in the deep oceans, because in the latter the sediment is probably more uniform. In the deep-water stations (27, 28, 29), however, the sediment is about 1,200 ft. thick in all three cases, and it may be that these are far enough away from land for deep-ocean deposition conditions to exist.

The layer with velocity 14,500 ft./sec. (4·4 km./sec.) shows at many of the Mediterranean stations. It is probably the same material at the deep stations 28 and 29, and may be the same also at station 27, which is much shallower, but was also a flat area. The velocity is within the range of limestone, volcanic flows and many other well-compacted materials. Seismic measurements at greater distances will be able to provide additional information in the future, and the results given here should be of assistance in choosing critical areas for further work.

The work of H.M.S. *Challenger* has been carried out by kind permission of the Hydrographer of the Navy, with the support of the Ministry of Supply, and the willing co-operation of the officers and men in H.M.S. *Challenger* has made the work possible.

One of us (T. F. G.) is indebted to the chairman and directors of the Anglo-Iranian Oil Company for leave of absence to take part in the expedition.

[May 12.

[1] Gaskell, T. F., and Swallow, J. C., *Nature*, **167**, 723 (1951): **170**, 1010 (1952).

[2] Cooper, Harrison and Willmore, *Phil. Trans. Roy. Soc.*, **A, 244**, 533 (1952).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Relation between Frank Spirals and Spiral Pits in Crystals

In previous communications[1,2], the occurrence of spiral pits on crystals of some substances has been described. The phenomenon has been attributed to the presence of screw dislocations in the crystal, and a detailed analysis of the growth mechanism based on this assumption has been given[3,4]. It has also been suggested that, when a spiral pit is present on the upper surface, the lower surface should exhibit a Frank spiral (spiral hill)[5], at least when the dislocation line extends through the crystal plate[4]. It has now been possible to obtain strong evidence that this is indeed the case.

Crystals of potassium ferrocyanide, growing while floating on an aqueous solution of this substance, exhibit octagonal or square (sometimes hexagonal or lozenge-shaped) polygonized growth spiral pits which are, according to theory[4], turned over a small angle with respect to the periphery of the face (Figs. 1–4) By using monochromatic light and provided the crystals are sufficiently thin, fringes always appear at the centre of the spiral during growth, extend and leave the face. The interferometer is evidently formed by the upper and lower face of the crystal plate. Fig. 1, made by means of an ordinary metallographic microscope, shows a simple spiral and the fringe system centred on it, while Fig. 2, photographed somewhat later, shows the extension of the fringe system. The deviation of the fringes proves that there is a pit on the upper surface, and from it the step height can be measured. Fig. 3 shows two co-operating spirals (pits) on the upper surface, while the fringes reveal that, on the underneath surface, growth is starting on points situated exactly under the centres of the spirals. These observations allow us to conclude unambiguously that, on the underneath surface, growth takes place by means of layers which persistently spread out from a centre lying exactly under the centre of the spiral pit, which was assumed to be the emergence point of a screw dislocation. As the supersaturation is relatively high with the mode of growing used, individual layers are practically never resolved on the underneath surface. As it is, however, now well established that vicinal hills are, in fact, Frank spirals, we believe that our observations give very strong evidence that on the underneath surface growth proceeds by means of a Frank spiral centred on the same dislocation line as the spiral pit. Furthermore, Fig. 5 gives direct evidence that growth of these crystals can take place by means of Frank spirals. It is, moreover, now evident that Frank spirals and spiral pits have a common origin, that is, a dislocation.

This work is part of a research scheme supported by I.R.S.I.A. (C.E.S.). One of us (E. V.) is indebted to the Carbon and Carbide Corporation for a research fellowship. We thank Prof. W. Dekeyser for his continuous interest.

S. Amelinckx
E. Votava

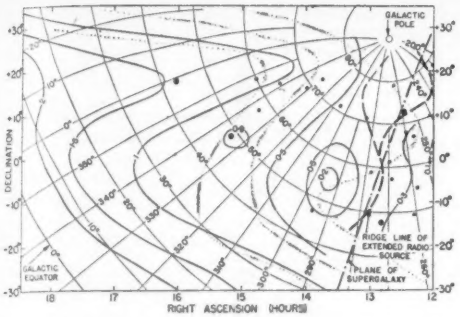
Crystallographic Laboratory,
Geological Institute,
University of Ghent.
May 6.

[1] Amelinckx, S., *Naturwiss.*, **39**, 547 (1952).
[2] Votava, E., Amelinckx, S., and Dekeyser, W., *Naturwiss.*, **40**, 143 (1953).
[3] Amelinckx, S., *Phil. Mag.*, **44**, 337 (1953).
[4] Amelinckx, S., *J. Chim. Phys.*, [**50**, 219 (1953)].
[5] Frank, F. C., Farad. Soc. Disc., No. 5 (1949).

Radio Radiation from the Supergalaxy

In March 1953, during a survey of the background radiation at 250 Mc./s. with the Ohio State radio telescope[1,2], a low-intensity source was observed near R.A. 13h. extending at least from Dec. − 15° to + 15°. Further measurements indicate that the maximum or ridge line of this source extends along the dashed curve shown in the accompanying figure. Near Dec. + 15° the ridge becomes double. The solid contours in the figure show the measured variation in background intensity at 250 Mc./s. Galactic co-ordinates are superposed on the figure, with celestial co-ordinates (1950.0) indicated along the edges.

An interesting feature of the extended source (shown by the dashed line) is that it corresponds approximately in position to the plane of our local supergalaxy described by de Vaucouleurs[3], and shown approximately in the figure by the dash-dot curve. The half-power width of the source is about 15° (in R.A.), which corresponds roughly to the width indicated by de Vaucouleurs. The radio intensity of the source rises above the background at Dec. − 5° by about 1×10^{-25} W.m.$^{-2}$ (c./s.)$^{-1}$/deg.$^{-2}$. These facts suggest the likelihood that the extended source is caused by radio radiation from our local supergalaxy (or galaxy of galaxies).



The solid curves are contours of cosmic radio noise (radio isophotes) measured at 250 Mc./s. Their absolute intensity is given approximately by the contour value multiplied by $1{\cdot}4 \times 10^{-24}$ W.m.$^{-2}$ (c./s.)$^{-1}$ deg.$^{-2}$

The solid dots in the figure give the locations of the dense clusters of galaxies from the map of Neyman, Scott and Shane[4].

Another noteworthy feature of the contour map is the long finger at Dec. + 20°, extending almost from the galactic equator to the galactic north pole. It has been observed also by Bolton and Westfold[5] in a survey at 100 Mc./s., and several of their extreme (lowest intensity) contours are here shown by the light dotted curves. It is not apparent from measurements to date whether this prominent feature is of galactic or extra-galactic origin.

The contours in the figure do not take into full account some gradual gradients in background intensity in both right ascension and declination. However, the positions of the essential features of the map are not affected by their presence.

J. D. Kraus
H. C. Ko

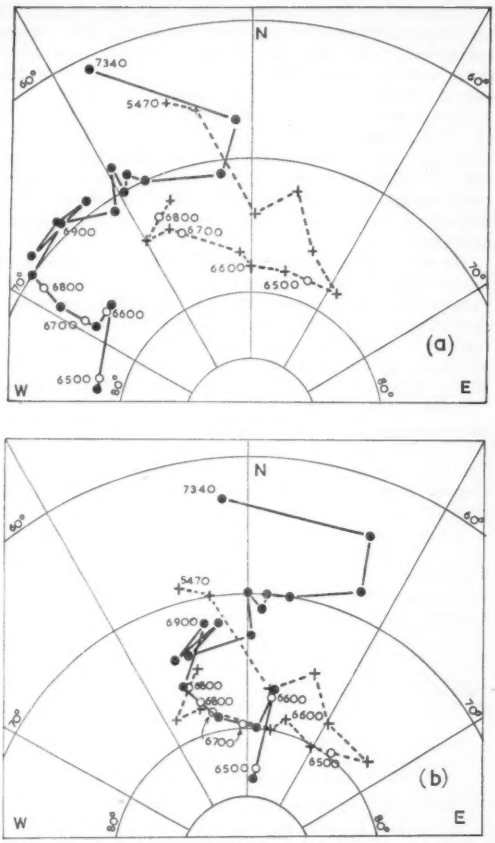
Radio Observatory,
Department of Electrical Engineering,
Ohio State University,
Columbus 10, Ohio.
June 10.

[1] Kraus, J. D., *Sky and Telescope*, **12**, 157 (1953).
[2] Kraus, J. D., and Kslazek, E., *Electronics*, **26**, 148 (1953).
[3] de Vaucouleurs, G., *Astro. J.*, **58**, 30 (1953).
[4] Neyman, J., Scott, E. L., and Shane, C. D., *Astrophys. J.*, **117**, 110 (1953).
[5] Bolton, J. G., and Westfold, K. C., *Aust. J. Sci. Res.*, **3**, 19 (1950).

Remanent Magnetism of Varved Clays from Sweden

A recent discussion on the remanent magnetism of rocks[1] revealed that its origin is not yet fully understood. Some investigations[2] do, however, suggest that the polarization direction of sediments may be due to orientation in the earth's field during deposition of contained ferromagnetic particles. Such rocks may therefore provide information about the earth's field in past times. The measurements on Swedish varved clays described in this communication were made in order to test these ideas further.

Varved clays are laid down by rivers draining glaciated areas. Thus, in Scandinavia widespread deposition followed the Pleistocene Glaciation, and in northern areas deposition is still taking place at the present time. The clays show a marked lamination, the result of annual variation in the stream load. By means of the thickness variations of the layers, sections in different localities have been correlated and a record obtained covering several thousand years of deposition. This has been dated, and thus the age of any varve layer can be given.



Direction of remanent magnetism of Swedish varved clays: (*a*) uncorrected and (*b*) corrected for dip. Dates in years on Lidén's time scale where 7602 equals A.D. 1000. ●—●, Prästmon; + – – + – –, Undrom; ○, interpolated points

In 1951, orientated specimens from varve series covering approximately the periods A.D. 1000–A.D. 0 and A.D. 500–500 B.C. were collected from Prästmon and Undrom, two localities about five miles apart in Ångermanland, Sweden. These varves were originally precisely dated by Lidén[3], but only an approximate correlation was obtained between the series collected, though the error was small. The polarization directions were measured with an A.C. magnetometer, a modified version of the apparatus described by Johnson[4].

These directions, plotted on a stereographic projection, are shown in Fig. (*a*), each point representing the average of five values. The mean deviations are 2°. It will be seen that there is considerable difference between the polarization directions for varves of the same age at the two localities. However, if the assumption is made that the layers were horizontal when deposited, and the magnetic vectors rotated to correct for the 3° dip of the beds at Undrom and the 12° dip at Prästmon, then quite close agreement is obtained between the two sets of values for points of corresponding age. The corrected values are shown in Fig. (*b*). The mean difference between

the directions for the four interpolated points for the years 6500–6800 is, before correction, 13°; after correction, it is only 3°. The range of values when corrected is reasonable if secular variation of the earth's field is the cause of change.

This agreement is unlikely to be fortuitous, and the inference is therefore that the polarization direction was controlled by the earth's field during deposition of the sediment. It appears also from this agreement that the beds were laid down horizontally, a fact not supported by the geological evidence.

Further measurements on other material are being made. In co-operation with Swedish investigators, varves laid down during the past few hundred years have been obtained from a river delta using a non-magnetic core sampler. The polarization directions of these will be compared with observatory records of the earth's field for the corresponding period.

I am grateful to a number of people for advice and assistance, notably Prof. P. M. S. Blackett, Dr. S. K. Runcorn, Mr. R. F. King, and, in Sweden, Dr. Carl Caldenius of the Geological Survey, Prof. Gustav Ising and Mr. Lars Granar. I thank the Royal Society for a generous grant.

D. H. Griffiths

Department of Geology,
University of Birmingham. April 29.

[1] Bruckshaw, J. M., *Nature*, **171**, 500 (1953).
[2] Johnson, E. A., *et al.*, *Terr. Mag. Atmos. Elect.*, **53**, 349 (1948). Torreson, O. W., *et al.*, *J. Geophys. Res.*, **54**, 111 (1949). Graham, J. W., *J. Geophys. Res.*, **54**, 131 (1949). Nagata, T., *J. Geophys. Res.*, **54**, 404 (1949). Ising, G., *Ark. Mat. Astr. Fys.*, **29** A, No. 5, 1 (1942).
[3] Lidén, R., *Geol. Fören. Förhandl.*, **60**, H3, 397 (1938).
[4] Johnson, E. A., *Rev. Sci. Instr.*, **9**, 263 (1938).

Generation of Weak Shock Waves

Because of the non-linearity of the pressure–volume relationship for air, different parts of a sound wave of finite amplitude propagate at different velocities. The wave distorts as it advances and shock fronts may be produced. Sound pulses which distort at a rate convenient for investigation of the phenomenon can be generated by discharging a condenser through the voice coil of a loudspeaker.

Fig. 1 shows the construction of the loudspeaker used. The cylindrical paper former carrying the voice coil V is glued to the aluminium diaphragm D and fits into the narrow gap of the magnet M. The rigid central portion of the diaphragm is in the shape of a shallow spherical cap and moves as a piston; the sound waves rapidly become plane in the propagation tube T of $1\frac{1}{2}$ in. diameter. The wave-form of the leading part of a typical pulse soon after generation is shown in Fig. 2; a choke in series with the voice coil prevents small irregularities in the wave-form.

In the present case the maximum pressure that can be generated is determined by the mechanical strength of the voice coil and not, as in normal continuous working, by the efficiency of heat dissipation from the coil. With 240 volts on the 8 μF. condenser, a leading half-cycle of compression is produced with a peak pressure of 3 cm. mercury; the maximum peak pressure when the leading half-cycle is made one of rarefaction is somewhat less. The pulses are extremely reproducible when a mica condenser and a mercury switch are used. With other types of condenser the pressure amplitude of a pulse depends on the time of charging the condenser and other factors.

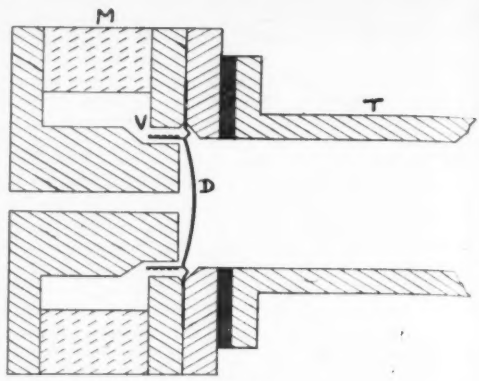


Fig. 1

Stokes[1] determined theoretically the distortion that would occur in a sound-wave, of given initial particle velocity–distance wave-form, under isothermal conditions. His construction, modified for a pressure–distance wave-form and adiabatic conditions, consists of drawing through any point R in the wave-form where the excess pressure is Δp, a line RS in the positive direction, parallel to the propagation axis, of length

$$c\,\frac{(\gamma+1)}{2\gamma}\,\frac{\Delta p}{p}\,t,$$

where c is the velocity of sound of infinitesimal amplitude, p is the atmospheric pressure and γ is the ratio of the principal specific heats; the locus of the points S for all the values of Δp is the wave-form after a time t. The construction is not valid beyond the point when a shock front is formed.

It has been shown experimentally by me, using a detector of uniform and high-frequency response[2], that the change in the shape of a sound pulse agrees

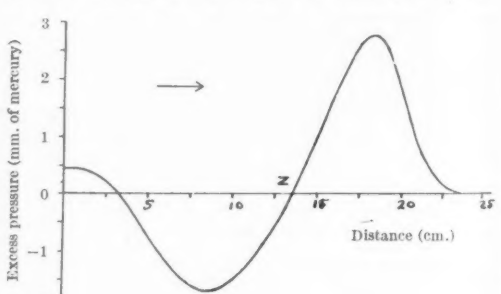


Fig. 2

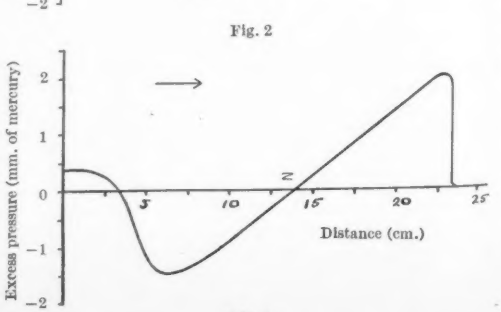


Fig. 3

closely with that predicted by this construction; the agreement with the theory (which neglects energy-dissipating agencies) is closest for pulses so strong that the distortion is rapid compared with the attenuation.

In general, a pulse eventually forms a shock front as in Fig. 3 (which is the pulse of Fig. 2, 6 millisec. later, that is, after propagation over a further 200 cm.). The velocity of propagation of the shock front of strength ΔP, relative to the point Z of zero excess pressure (which travels at velocity c), has been found to be slightly higher than the theoretical value

$$c\,\frac{(\gamma+1)}{4\gamma}\,\frac{\Delta P}{p}$$

derived from Rankine's paper[3].

V. Timbrell

Physics Department,
Imperial College of Science and Technology,
South Kensington, London, S.W.7.

[1] Stokes, G. G., *Phil. Mag.*, (3), **33**, 349 (1848).
[2] Timbrell, V., *Nature*, **167**, 306 (1951).
[3] Rankine, W. J., *Phil. Trans. Roy. Soc.*, **160**, 277 (1870).

Nucleic Acid Template Hypotheses

In a recent review and discussion of protein synthesis, Campbell and Work[1] have discussed a hypothesis for peptide chain synthesis published by me[2]; but in spite of rather favourable comments on this particular hypothesis, these authors have attempted to raise certain objections against the general concept that nucleic acids might be templates for protein synthesis. However, there seems to be a certain tendency to confuse nucleic acid template hypotheses with nuclear template hypotheses, where the word 'nuclear' refers to the nucleus of the cell.

In the hypothesis proposed by me, ribonucleic acid was deliberately chosen as the template, since it seems probable from a number of considerations and experimental investigations that protein synthesis may occur in cytoplasm as well as in nuclei. There can be no objection at the present time to assuming that the genes are templates, but it is not necessary to assume that the genes act directly as templates for protein synthesis. If we accept for the purposes of argument the suggestion of Mazia[3] that genes are composed of deoxyribonucleic acid, then it could conceivably happen that the deoxyribonucleic acid gene molecules would act as templates for ribonucleic acid synthesis, and that the ribonucleic acids synthesized on the gene templates would then in turn become templates for protein synthesis in the nucleus or cytoplasm or both. As a matter of fact, the recently discovered higher rate of turnover for nuclear than for cytoplasmic ribonucleic acid[4–10] would seem to lend some support to such an idea, as would the reported loss in cytoplasmic ribonucleic acid of amœbæ after denucleation[11,12]. However, a consideration of plasma genes and virus synthesis leads to the concept of an independent ribonucleic acid synthesis not involving nuclear genes. The concept expressed by Spiegelman and Kamen concerning the relationship between plasma genes and nuclear genes[13] could be explained by the template sequence deoxyribonucleic acid – ribonucleic acid – protein, with the additional postulate of a co-existing independent ribonucleic acid synthesis with ribonucleic acid acting as its own template.

Another objection raised by Campbell and Work against the participation of nucleic acid in protein synthesis is the lack of proved correlation between nucleic acid synthesis and protein synthesis. However, such lack of correlation is not an objection to the mechanism proposed by me, since a zero or inverse correlation could just as well be predicted, as can be inferred from what is said in the original article[2] concerning the ratio of substrates available in the cell for nucleic acid and for protein synthesis in a given time interval. There is no necessity for assuming any particular relationship between the rate of synthesis of a template and that of the product produced by the aid of this template. The only requirement is that the template be synthesized rapidly enough to be maintained at a suitable concentration in the cell.

If it is assumed that deoxyribonucleic acid has any function in the resting cell, it can be seen at once that such function could not correlate with deoxyribonucleic acid turnover, since the latter appears to be very low or zero in the resting cell. In fact, the maximum life-span of a resting cell might well be determined by the life-span of the deoxyribonucleic acid molecules contained therein, since all other types of molecules appear to have relatively high rates of turnover.

This note is by no means intended as an adverse criticism of the excellent review and discussion written by Campbell and Work, since it is obviously concerned with only one point in their article. The template hypothesis constructed by me was published mainly in the hope of promoting thinking and experimentation of a detailed nature concerned with the possibility that nucleic acids may participate in protein synthesis. It will be gratifying if this aim is achieved.

I am grateful to the National Cancer Institute of the National Institutes of Health for its support.

Alexander L. Dounce

Department of Biochemistry,
University of Rochester
School of Medicine and Dentistry,
Rochester, New York.
July 10.

[1] Campbell, P. N., and Work, T. S., *Nature*, **171**, 997 (1953).
[2] Dounce, A. L., *Enzymologia*, **15**, 251 (1953).
[3] Mazia, D., in "Modern Trends in Physiology and Biochemistry", edited by E. S. G. Barron, 77 (Academic Press, New York, 1952).
[4] Bergstrand, A., Eliasson, N., Hammarsten, E., Norberg, B., Reichard, P., and Ubisch, H. v., Cold Spring Harbor Symposia on Quant. Biol., **13**, 22 (1948).
[5] Marshak, A., and Calvert, F., *J. Cell. Comp. Physiol.*, **34**, 451 (1949).
[6] Barnum, C. P., and Huseby, R. A., *Arch. Biochem.*, **29**, 7 (1950).
[7] Jeener, R., and Szarfarz, D., *Arch. Biochem.*, **26**, 54 (1950).
[8] Hurlbert, R. B., and Potter, V. R., *J. Biol. Chem.*, **195**, 257 (1952).
[9] Smellie, R. M. S., and McIndoe, W. M., *Biochem. J.*, **52**, Proc. xxii (1952).
[10] Smellie, R. M. S., McIndoe, W. M., Logan, R., Davidson, J. N., and Dawson, I. M., *Biochem. J.*, **54**, 280 (1953).
[11] Mazia, D., and Hirshfield, H. I., *Science*, **112**, 297 (1950).
[12] Brachet, J., *Experientia*, **6**, 294 (1950).
[13] Spiegelman, K., and Kamen, M., *Science*, **104**, 581 (1946).

There is, we think, less difference of opinion between us than Dr. Dounce suggests. We took particular care to present the case for and against each current hypothesis, because we ourselves have no strong predilection for any theory and prefer at the present embryonic stage of the subject to keep an open mind.

Our paragraph headed "Objections to the Template Theory" was not intended to suggest that nucleic acids cannot act as templates for protein synthesis

but rather to direct attention to the difficulty of any hypothesis which postulates a one-to-one relationship between genes and proteins. It is true, as suggested by Dr. Dounce, that there is no need to assume that genes act directly as templates; we can assume instead that genes synthesize ribonucleic acid templates and that these control protein synthesis. If, however, there were a specific gene for each ribonucleic acid template and a specific ribonucleic acid template for each protein, we should still have a one-to-one relationship between genes and proteins. It is particularly upon this concept of a one-to-one relationship between genes and proteins that we wished to cast doubt.

With regard to Dr. Dounce's second point, the correlation between rates of nucleic acid template synthesis and protein synthesis, we agree that it is not necessary to assume a direct proportionality between the two. It should be remembered, however, that much of the evidence for a relationship between nucleic acid synthesis and protein synthesis is based on experimental observations showing that under most conditions the two run closely parallel to one another. It seems to us illogical to accept this indirect evidence as support for the idea of participation of nucleic acids in protein synthesis, if, as suggested by Dr. Dounce, the theory does not in any case require a relationship between the rates of nucleic acid and protein synthesis.

T. S. Work
P. N. Campbell

National Institute for Medical Research,
Mill Hill, London, N.W.7.

Origin of Striations in Discharges

Alternate dark and bright regions are a common feature of the positive column of a glow discharge in most gases. Such striations may be stationary or moving and the column will be uniform or striated depending upon the gas pressure, the current density and the radius of the tube. The existence of striations has been known for more than a century, but the mechanism of their appearance or absence is still obscure.

Stationary striations are generally attributed to some regularity which produces repetitions of the Faraday dark space. As a result of experiments, Donahue and Dieke[1] conclude that moving striations are due to regions of positive and negative space charge which travel towards the electrodes, and they suggest that the process is initiated by the accumulation of electrons in the negative glow region. On the other hand, Loeb[2] has suggested that the striations may be associated with plasma oscillations.

In the positive column of a discharge the electron and ion densities are substantially equal (that is, form a plasma), and under such conditions the charges may vibrate under the influence of the electrostatic forces. For electrons the frequency of oscillation has been calculated, with simplifying assumptions, to be 8,980 $n^{1/2}$ c./s., where n is the charge density, and frequencies of this order (for example, about 10^9 c./s.) have been observed[3]. If an electrical wave of sufficiently short length is propagated through the plasma and a standing wave set up, then striations may be accounted for by the positions of the nodes and antinodes. This mechanism would also account for moving striations, for the position of the standing wave system will depend upon the phase change on reflexion of the incident wave at the head of the column, and if the electron density there changes the striations will move. A sufficiently rapid movement will give rise to an apparently uniform column.

On this view of the mechanism the striations have their origin in the plasma itself, whereas on the other theories the effect is due to cathode phenomena. In order to investigate the matter, it is desirable to make observations under the simplest possible conditions. This may be done by using high-frequency excitation, so that the plasma is obtained in an isolated state. Due to the alternation of the field, there is no unidirectional loss of electrons (as in a D.C. discharge) so that secondary electron production is unnecessary and the cathode fall is absent. The conditions in the high-frequency glow are then similar to those in the D.C. positive column and the discharge is maintained at a low voltage. The high-frequency field is usually applied by means of sleeve electrodes wrapped on the outside of the tube, and stationary striations aligned along the axis of the tube and in the direction of the field have been observed in a number of gases[4]. Gale[5] has recently described striations obtained by placing a long discharge tube between the wires of a Lecher system. High-frequency glows were observed over regions corresponding to the voltage antinodes, and the striations in these glows were aligned along the axis of the tube, that is, at right angles to the field. Thus it appears that the direction of alignment of the striations is determined by the geometry of the plasma (that is, the shape of the tube) rather than by the direction of the exciting field. Any effect due to the electrodes may be eliminated if the electrodeless form of discharge is observed. In this case the electric field is induced by an alternating magnetic field and the glow is obtained in the form of a ring, and is, in effect, a plasma of infinite length. Striations in this form of glow have been described by Sir J. J. Thomson[6]. The bright and dark portions were radial, but were unsteady and flickered rapidly.

Thus the evidence presented by the occurrence and alignment of striations in high-frequency glows shows that they are a property of the plasma itself rather than due to a cathode mechanism, and supports the view that they may be due to a standing wave system associated with oscillations of the charges constituting the plasma.

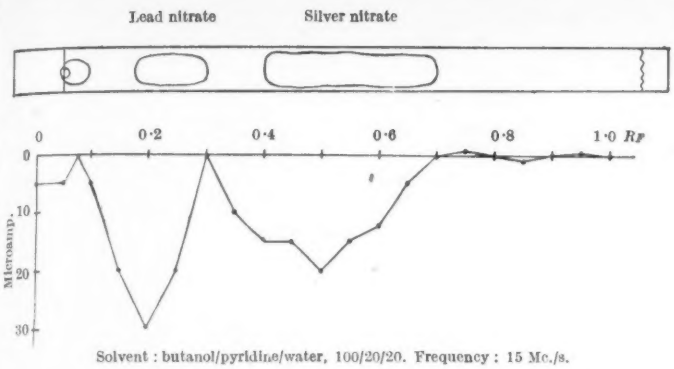
G. D. Morgan

Department of Physics,
University College of North Wales,
Bangor.
July 24.

[1] Donahue, T., and Dieke, G. H., *Phys. Rev.*, **81**, 248 (1951).
[2] Loeb, L. B., "Electrical Discharge in Gases", 573 (Wiley, 1939).
[3] Tonks, L., and Langmuir, I., *Phys. Rev.*, **33**, 195 (1929).
[4] Hayman, R. L., *Phil. Mag.*, **7**, 586 (1929). Townsend, J. S., and MacCallum, S. P., *Phil. Mag.*, **12**, 1168 (1931). MacCallum, S. P., and Klatzow, L., *Phil. Mag.*, **15**, 829 (1933).
[5] Gale, G. O., *Amer. J. Phys.*, **21**, 389 (1953).
[6] Thomson, Sir J. J., *Phil. Mag.*, **4**, 1128 (1927).

High-frequency Papyrography of Salts

A method termed 'high-frequency papyrography', by which chemical substances and, in particular, electrolytes may be readily detected, has already been reported[1]. The process involves the movement of the papergram between the plates of a condenser in a tuned-grid-type high-frequency circuit, when large changes in the grid current are observed.



Solvent : butanol/pyridine/water, 100/20/20. Frequency : 15 Mc./s.

We have investigated the use of frequencies from 500 to 15,000 kc./s. and have found that the lower frequencies (500–5,000 kc./s.) promote greater sensitivity than the higher. We also find that each substance has an optimum frequency for maximum sensitivity. Further work is in progress in this direction.

The point of maximum concentration (required for calculation of R_F) is readily established (see diagram) by the apparatus even in the case of long spots caused by overlapping or tailing, and the sensitivity of the method is such that less than 1 γ of an inorganic compound can readily be detected. The sensitivity may be increased by the use of stronger currents.

It is essential that uniform filter paper should be used; any quantitative filter paper will become almost electrically uniform after electrolysis, as previously described[1]. However, precise quantitative results will not be obtained until a filter paper with less background 'noise' is available. To this end, the solvents used in the papergram must leave no residue, since the smaller the background 'noise' the higher the sensitivity. The results obtained are as illustrated.

We have investigated the use of electric conductometry at mains frequencies, but the results were inferior to those obtained using high-frequency currents.

YOHEI HASHIMOTO
ITSOHIKO MORI

Institute of Phytochemistry,
Kobe College of Pharmacy,
Mikage P.O.,
Kobe.

[1] *J. Pharm. Soc. Jap.*, **72**, 1532 (1952).

Influence of Cations on the Ninhydrin Reaction for the Determination of Amino-Acids

THE micro-determination of α-amino-acids with ninhydrin in *n*-butanol is highly sensitive, but often inaccurate due to the retardation of colour formation and the production of various red or blue colours instead of the purple compound usually obtained. It was found that traces of cations had a marked influence on the speed of colour formation and its intensity and on the absorption spectra of the coloured compounds produced. (The effect of cations on the ninhydrin colour was employed for the preservation of chromatogram spots by Kawerau and Wieland[1].)

The addition of 0·1 ml. of a *M*/100 solution of any of the cations, Al^{3+}, Hg^{2+}, Fe^{2+}, Fe^{3+}, Mn^{2+}, Sn^{2+}, Ag^{+} and Cu^{2+}, to a reaction mixture consisting of 10 μgm. alanine in 0·1 ml. water and 3 ml. of a 0·1 per cent solution of ninhydrin in *n*-butanol entirely abolished colour formation, which readily takes place when the reaction mixture is refluxed for ten minutes without the addition of cations. The presence of Ca^{2+}, Ba^{2+} and Cd^{2+} caused the formation of red colours with absorption maxima at 510 and 410 mμ (Ca^{2+} and Cd^{2+}) and 530 and 410 mμ (Ba^{2+}), which were spectrophotometrically detectable when about 1 μgm. of the cation was added to the reaction mixture. The absorption maximum of the normal colour at 570 mμ was progressively diminished and disappeared entirely when 20 μgm. of cation were present. The cation effect could be entirely eliminated by the addition of the chelating agent versene (the disodium salt of ethylene-tetraacetic acid). The coloured compound produced in its presence was uniform and had sharply defined absorption maxima at 570 and 410 mμ. The sensitivity of the reaction was considerably enhanced and exceeded that obtained by the addition of pyridine.

Good quantitative results could be obtained by employing the following method. A mixture, consisting of 0·1 ml. of the aqueous solution (containing 5–50 μgm. of the amino-acid to be determined), 0·3 ml. of a 0·3 per cent solution of versene in *M*/15 citrate buffer (pH = 5) and 3 mgm. ninhydrin dissolved in 3 ml. of aldehyde- and peroxide-free *n*-butanol, is refluxed for fifteen minutes in a 'Pyrex' reagent tube (20 × 250 mm.), using a cold finger condenser. After cooling, the mixture is diluted to 10 ml. with 50 per cent (v/v) ethanol and measured in any suitable photoelectric colorimeter at 570 mμ. The colour is stable for at least ten hours.

The method is easily adaptable for the evaluation of chromatogram spots. In this case, the spots should be located on the paper by one of the methods not employing the ninhydrin reaction[2]. The spots are cut out, the paper is cut into small pieces, added to the reaction mixture and treated as described above.

The method allowed the determination of the amino-acids glycine, valine, leucine, *iso*leucine, threonine, serine, lysine, arginine, histidine, glutamic acid, aspartic acid, tyrosine and methionine in the range of 0·3–4·0 gm. amino nitrogen, with an average accuracy of ± 3 per cent. The relation of optical density to concentration was linear over the same range.

HANAN MEYER
EMANUEL RIKLIS

Department of Biological and Colloidal Chemistry,
Hebrew University,
Jerusalem, Israel.
June 24.

[1] Kawerau, E., and Wieland, T., *Nature*, **168**, 77 (1951).
[2] Block, R. J., LeStrange, R., and Zweig, G., "Paper Chromatography", 61 (Acad. Press, New York, 1952).

Riboflavine and Thiamine Contents of Saffron, *Crocus sativus* Linn.

Four authenticated samples of saffron were analysed by us for the presence of riboflavine and thiamine by use of the spectrophotometer. An acetic acid buffer (*p*H 4·5) extract of saffron to which papain was added was taken. The pigment in the extract obtained (after destroying the enzyme papain by heating) was destroyed by addition of 10 ml. of 4 per cent potassium permanganate after adjusting the extract to *p*H 3·7 with glacial acetic acid. Hydrogen peroxide was added to destroy the excess of permanganate. The filtrate obtained was made up to volume and its fluorescence read on a spectrophotometer. The presence of fluorescing substances other than riboflavine was ruled out because on addition of sodium hydrosulphite solution in 0·2 *M* disodium phosphate, no fluorescence was observed, which would not have been the case had fluorescent substances other than riboflavine been present in the extract[1]. By treating an aliquot of the permanganate extract obtained above with alkaline potassium ferrocyanide and isobutyl alcohol, the thiamine was oxidized to thiochrome[2] which gets transferred to the isobutyl alcohol layer because of its greater solubility in that solvent. After drying this extract over anhydrous sodium sulphate, readings for thiamine were taken on the spectrophotometer.

The results of the analysis are presented in the accompanying table. Along with the results obtained for saffron, the riboflavine contents of other foods considered to be rich sources of this vitamin, and also some plant parts classed as spices, have been presented.

Product or plant	Plant part	Thiamine γ/gm.	Riboflavine γ/gm.	Authors
Saffron :				
Sample I		4·0	138	
„ II		3·8	93·3	
„ III		0·72	78·7	
„ IV		0·88	56·4	
Beta vulgaris	Leaves		20	Cheldelin and Williams, 1942
Spinacea oleracea	Leaves		22	Cheldelin and Williams, 1942
Cucurbita mexicana	Dry flowers		25	Cravioto *et al.*, 1945
Avena sativa	Coleoptile of embryo		20	Cravioto *et al.*, 1945
Ferula narthex	Gum resin from root			Aykroyd, 1951
Allium sativum	Bulb			Aykroyd, 1951
Myristica fragrans	Rind			Aykroyd, 1951
Marmite			33	Morton, 1942
Dry egg albumin			14·1	Morton, 1942
Dried yeast			30–50	Morton, 1942
Dried whey			20	Morton, 1942
Fresh ox liver			15·9	Morton, 1942
Calf liver			32	Elvehjem, 1943
Pork liver			27	Elvehjem, 1943

It will be noticed that saffron or the stigmas of *Crocus sativus* Linn. are easily the richest known source of vitamin B_2 or riboflavine. The thiamine or vitamin B_1 content is, however, insignificant.

High values for riboflavine contents of two of the saffron samples chemically analysed by us have also been secured by Dr. K. K. Iya and Mr. Sreenivasamurthy of the Indian Dairy Research Institute, Bangalore, who carried out the microbiological assay using *L. plantarum*-89 as the test organism. The authors are grateful to them for their kind co-operation.

J. V. Bhat
Rajul Broker

Pathological Laboratories,
St. Xavier's College,
Bombay. May 4.

[1] Scott, M. L., Hill, F. W., Norris, L. C., and Heuser, G. F., *J. Biol. Chem.*, **165**, 65 (1946).
[2] The Association of Vitamin Chemists, Inc., "Methods of Vitamin Assay", 107 (Interscience Publishers, Inc., New York, 2nd edit., 1951).

Fibrinolysis by Adsorption

The plasma of normal people has been shown to contain a labile, active fibrinolysin[1,2,3]. Since this enzyme is not necessarily plasmin and in some ways behaves differently from plasmin, it has been tentatively termed 'plasma active fibrinolysin'[2]. The enzyme disappears rapidly from fluid blood and plasma kept at room temperature; but if blood is cooled immediately when taken and centrifuged at low temperature and the resultant plasma is diluted and clotted, lysis of the clots occurs within 24 hr. incubation at 37° C.[2]. Enzyme activity is insufficient to cause anything but slow and variable lysis of whole plasma clots[4]. Since lysis occurs on incubation, the enzyme is evidently stabilized once clotting has taken place, presumably by adsorption on fibrin. This suggested that pre-formed plasma clots might absorb the enzyme from fresh plasma. To investigate this possibility fifteen healthy individuals were studied. Citrated venous blood was obtained from each, and the resultant plasma kept at room temperature for 24 hours in order that all fibrinolytic activity should have disappeared. From this plasma, diluted 1 : 4 with a veronal saline buffer (*p*H 7·4), 1·0-ml. volume clots were made in small tubes by recalcification. The clots were ringed, removed from the tubes, and kept in normal saline for 2 hr.; clots made in this way do not retract appreciably, nor do they cause coagulation of added plasma. The subject was bled again, the blood being citrated and cooled immediately and then centrifuged at low temperature. Three of the clots described above were then placed in 3·0 ml. vol. of this plasma (fresh plasma) in tubes standing in ice and water. Adsorption was allowed to continue for 1 hr., the tubes being tilted every 2½ min. to ensure change of contact between clot and plasma. The clots were then washed thoroughly in saline. After the remainder of the plasma of the second bleeding had stood at room temperature for 4 hr., and had lost fibrinolytic activity, the above procedure was repeated exactly using this plasma (standing plasma) and three further clots. Control clots were placed in saline at 0° C. for 1 hr. The clots were then incubated in veronal saline buffer at 37° C. for 48 hr., and examined at intervals for lysis. Whereas no lysis of the clots treated with 'standing' plasma or of the controls occurred, on every occasion the clots treated with 'fresh' plasma underwent lysis of varying degree.

Further experiments showed that whole plasma clots made from silicone-taken blood (that is, no anticoagulant and no clotting agent were added) underwent considerable lysis on incubation after treatment with 'fresh' plasma but not after treatment with 4-hr. 'standing' plasma. Exercise of the subject before venepuncture increased the fibrinolytic effect of the plasma in which the clots were suspended. These data indicate that 'plasma active fibrinolysin' is present in undiluted plasma, from which it can

be concentrated on a clot surface by adsorption. Since arterial thrombosis is initiated by the formation of a mural thrombus, an adsorbable fibrinolysin, if present in circulating blood, while insufficient to impair hæmostasis, could be augmented sufficiently by adsorption to have a thrombolytic and anti-thrombotic function.

GEORGE R. FEARNLEY
Department of Medicine,
Postgraduate Medical School of London.
June 16.

[1] Fearnley, G. R., Revill, R., and Tweed, J. M., *Clin. Sci.*, **11**, 309 (1952).
[2] Fearnley, G. R., and Tweed, J. M., *Clin. Sci.*, **12**, 81 (1953).
[3] Truelove, S. C., *Clin. Sci.*, **12**, 75 (1953).
[4] Ratnoff, O. D., *Bull. Johns Hopkins Hosp.*, **84**, 29 (1949).

Effect of Diuresis on Uptake of Radioiodine (^{131}I) by the Thyroid

In the past two years, radioiodine uptake has been studied in more than two hundred patients. From the analysis of our results, we are able to draw certain conclusions concerning the effect of diuresis on the urinary excretion of radioiodine. The iodine-131 was supplied from Harwell.

After administering the radioiodine to the subject, the urine is collected at frequent intervals for 104 hours. The usual tracer dose is 200 μC. while the average single effective dose is 5·5 mC. No special recommendations were given to the patients concerning the fluid intake. Fig. 1 shows the variation of the amount of iodine-131 excreted in urine during the first four hours as a function of the total water output during the same time. Patients are divided in groups following the total amount of the dose excreted. The water output varied from 50 c.c. to 750 c.c. Our results indicate that the uptake of radioiodine by human subjects is not affected by the diuresis, the latter being essentially dependent on the fluid intake.

Our observations indicate also a linear relationship between the percentage of the total dose of iodine excreted during four days and the amount excreted during the first four hours after administration. However, this observation is only valuable when we consider the mean values; the individual fluctuations observed are important because the variations are such that it is impossible to use this standard curve in order to determine the total uptake by the thyroid gland. It is to be noticed that the fluctuations are of less importance for patients with hyperthyroidism who excrete a low percentage of the dose. In the latter, the urinary excretion during the first four hours will give a rather good picture of the total uptake of the radioiodine.

So we may conclude that, in general, the urinary excretion of iodine-131 should be followed for a much longer time interval than four hours—an ideal time being forty-eight hours.

J. PAHAUT
J. GOVAERTS
P. BONHOMME

Radiological Department of the
Clinic of St. Joseph, Liège. July 22.

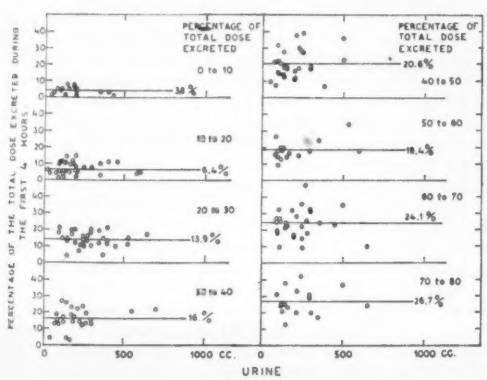
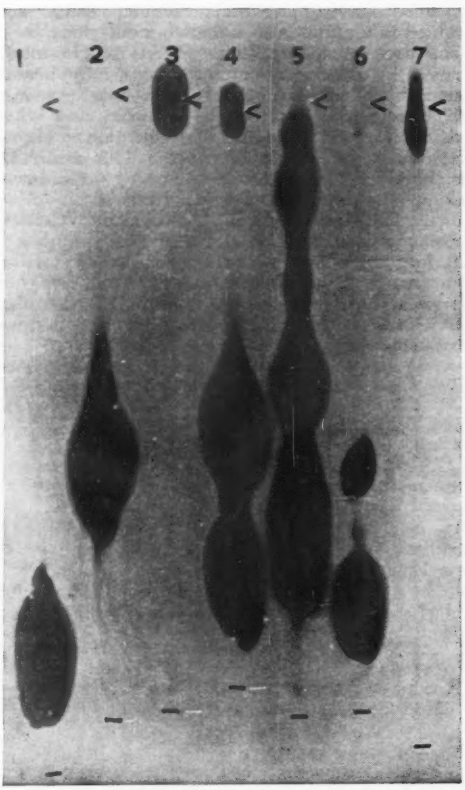


Fig. 1

Hydrophilic Penicillins produced by *Penicillium chrysogenum*

It has been shown[1-3] that a species of *Cephalosporium* produces an antibacterial substance, cephalosporin *N*, which is a new type of penicillin characterized by its insolubility in most organic solvents and by a similar order of activity against Gram-positive and Gram-negative bacteria[4].

In the course of experiments, the results of which will be reported elsewhere, on the incidence of this type of hydrophilic penicillin production by moulds and factors controlling their biosynthesis, it has now been found that *Penicillium chrysogenum* produces a



(1) Benzyl penicillin. (2) *p*. Hydroxybenzyl penicillin. (3) Cephalosporin *N*. (4) Mixture of 1, 2 and 3. (5) Carbon eluate from *Penicillium chrysogenum* fermentation without phenylacetamide. (6) Carbon eluate from *Penicillium chrysogenum* fermentation with phenylacetamide (0·06 per cent). (7) Penicillin *W* from 5. <, point of origin on paper strips. —, solvent front

number of antibiotics more hydrophilic than *p.* hydroxybenzyl penicillin. Since these are readily destroyed by penicillinase it is concluded that they are penicillins.

P. chrysogenum Q176 was grown in deep aerated culture in corn steep liquor/lactose medium with and without phenyl acetamide (0·06 per cent). After 96 hr. the mycelium was filtered off and the filtrate adjusted to *p*H 6 before percolating it through columns of active carbon previously buffered with sodium phosphate (0·8 *M*) at *p*H 6. After washing the columns with water they were eluted with 50 per cent (v/v) acetone in water, when active material was recovered in a narrow band. After removal of the acetone, the active fractions were dried from the frozen state. Solutions of the powders were chromatographed by a modification of the method of Goodall and Levi[5], using paper strips buffered with sodium acetate (0·1 *M*) at *p*H 5·4 and developing with ethyl acetate, previously equilibrated with the buffer at room temperature (19–20°). After drying, the strips were placed on agar seeded with *Staph. aureus* 209P, removed after 30 min. and the plates incubated at 30°. The results of such chromatograms are shown in the accompanying figure. It will be seen that, in the absence of phenylacetamide, there is evidence of three antibiotic zones above the *p.* hydroxybenzyl zone: in the presence of phenylacetamide the zones due to the *p.* hydroxybenzyl and to the more hydrophilic penicillins are suppressed. Similar results were obtained in a number of similar fermentations.

The more solvent-soluble penicillins may be totally removed by exhaustive extraction with ethyl acetate from carbon eluates adjusted to *p*H 3, leaving a single antibiotic (penicillin *W*) in the aqueous phase which remains very near the point of application in chromatograms performed as described. This antibiotic, like the others, is rapidly destroyed by penicillinase.

Comparison of the relative activities of various penicillins against *Staph. aureus* 209P and *Klebsiella pneumoniæ* (stock laboratory strain) using agar diffusion assay and cephalosporin *N* as standard gave results shown in the table. Of course, these relative activities must not be confused with absolute activities which can only be determined on the pure substances using dilution assays.

Penicillin	Apparent activity 'v' *Klebsiella* / Apparent activity 'v' *Staph. aureus*
Sodium benzyl penicillin	0·00092
Sodium *p.* hydroxybenzyl penicillin	0·0058
Penicillin *W*	0·162
Cephalosporin *N*	1·0

It is interesting, therefore, that penicillin *W* occupies a position intermediate between *p.* hydroxybenzyl penicillin and cephalosporin *N*. It should be emphasized that the hydrophilic penicillins described probably constitute only a small fraction of the total penicillins produced.

C. W. Hale
G. A. Miller
B. K. Kelly

Antibiotics Research Station
(Medical Research Council),
Clevedon. July 25.

[1] Burton, H. S., and Abraham, E. P., *Biochem. J.*, **50**, 168 (1951).
[2] Crawford, K., Heatley, N. G., Boyd, P. F., Hale, C. W., Kelly, B. K., Miller, G. A., and Smith, N., *J. Gen. Microbiol.*, **6**, 47 (1952).
[3] Abraham, E. P., Newton, G. G. F., Crawford, K., Burton, H. S., and Hale, C. W., *Nature*, **171**, 343 (1953).
[4] Heatley, N. G., and Florey, H. W., *Brit. J. Pharm. and Chemother.*, **8**, 252 (1953).
[5] Goodall, R. R., and Levi, A. A., *The Analyst*, **72**, 277 (1947).

Depletion of Gamma Isomer of Benzene Hexachloride in Cattle Dipping-Fluids

Benzene hexachloride dips are highly effective for the control of cattle ticks and have been used extensively for this purpose. However, it was reported from South Africa[1] and Australia[2] that the toxicity of the fluid declined after the initial charging of the vat, even though chemical analyses indicated little loss in the content of benzene hexachloride. The methods of chemical analysis used in the investigations mentioned above were, however, not specific for the gamma isomer, and the assumption had to be made that its concentration maintained a constant relation to that of the total benzene hexachloride. This assumption has now been found to be unjustifiable, as estimation of the quantities of isomers in cattle dipping-fluids, rendered possible by the development of an appropriate method of adsorption chromatography[3], indicates a depletion of the gamma isomer in dips sufficiently marked to account for the observed loss of toxicity to ticks.

Dips for the control of *Boophilus microplus* in Queensland are usually charged at the rate of 500 parts per million of gamma benzene hexachloride. When engorged female ticks are dipped in this concentration of gamma isomer, almost 100 per cent fail to lay viable eggs. Fluid taken from a dip which was charged initially at 500 parts per million of the gamma isomer, and which had been in practical use for some time, was examined shortly after sampling. The gamma-isomer content was found by adsorption chromatography to be not more than 50 parts per million, and immersion in the fluid prevented only 41 per cent of female ticks from laying viable eggs. Samples from other dips in active use also showed depletion, the gamma-isomer content ranging from 80 to 150 parts per million. Marked reduction in gamma benzene hexachloride content also occurred in samples which were taken from dips containing 500 parts per million gamma isomer and stored in the laboratory for four years, one being found to contain not more than 0·5 part per million. Such samples produce practically no reduction in the number of females laying viable eggs. As there may be considerable variation in the rate of charging and replenishment of dips, and also as samples for analysis may not be representative, a clearer picture of the depletion of gamma isomer is obtained by expressing the amount present as a percentage of the total benzene hexachloride in the sample. In freshly prepared dipping-fluid the 500 parts per million gamma isomer represents approximately 12 per cent of the total, the values of 50–150 parts per million in fresh samples from dips in practical use, as mentioned above, represent 2·8–4·1 per cent, and in the sample which had been stored in the laboratory for four years the 0·5 part per million of gamma isomer that was recorded was only 0·02 per cent of the benzene hexachloride present.

The method of adsorption chromatography does not permit the separation of the gamma isomer from the small quantity of epsilon isomer present in technical benzene hexachloride[4]. The values of gamma isomer given above are therefore maxima, and, although there is probably also a loss of epsilon isomer in some samples, the possibility must be considered that there is even complete exhaustion of gamma isomer in some cases, the residue measured by chromatography consisting exclusively of epsilon isomer.

The satisfactory level of tick control achieved with most benzene hexachloride dips in spite of the differential loss of the most toxic isomer is doubtless accounted for by the use of the acaricide at a high initial concentration, and frequent replenishment with freshly prepared fluid to replace that removed by dipped animals. Reduction in toxicity of dips to female ticks does not become marked until the concentration of gamma isomer falls below 100 parts per million.

Further studies are in progress, and detailed results will be published elsewhere.

W. J. Roulston
L. F. Hitchcock

Division of Entomology,
Commonwealth Scientific and
Industrial Research Organization,
Veterinary Parasitology Laboratory,
Fairfield Road,
Yeerongpilly, S.4, Queensland.
April 24.

[1] Whitnall, A. B. M., Bradford, B., McHardy, W., Whitehead, G. B., and Meerholz, F., *S. Afr. Sci.*, **2**, 112 (1948).
[2] Norris, K. R., Roulston, W. J., and Snowball, G. J., *Aus. J. Agric. Res.*, **1**, 165 (1950).
[3] Granger, C., and Zwilling, J.-P., *Bull. Soc. Chim. France*, **17**, 873 (1950).
[4] Granger, C., and Thiesse, X., *C.R. Acad. Sci., Paris*, **232**, 2456 (1951).

Non-Identity of Intermedin and Adrenocorticotrophic Hormone

It has been reported by Johnsson and Högberg[1] and Sulman[2] that some purified preparations of pituitary adrenocorticotrophic hormone have a strong dispersing action on the melanocytes of *Rana temporaria* and *Hyla arborea*, like the pituitary melanotropic hormone (intermedin), and from this and other arguments[1] they infer the identity of these hormones. However, later observations by Geschwindt *et al.*[3], Morris[4] and Lock[5] do not seem to be consistent with the hypothesis of Johnsson and Högberg[1] and Sulman[2], as (*a*) the melanotropic action of adrenocorticotrophic hormone could be separated from the corticotrophic, and (*b*) the treatment with 0·1 *N* alkali destroys the latter action to a large extent but leaves relatively unaffected or even potentiates the melanophore expanding action. If Johnsson and Högberg[1] and Sulman's[2] assumption were correct, highly purified preparations of intermedin would prevent, like adrenocorticotrophic hormone, the changes in the adrenals following hypophysectomy and restore the glands to their normal structure. In the toad *Bufo arenarum* Hensel, thirty days after complete removal of the pituitary, the adrenals appear atrophied, as the trabeculæ become thinner and the cortical cells lose most of the osmiophilic droplets (Fig. 1) observed in the normal controls (Fig. 2). If fifteen days after the hypophysectomy a daily injection of 100 μgm./100 gm. toad weight of adrenocorticotrophic hormone (from Armour and Co., lot J-80211) is started and continued for the following fifteen days, then the adrenals show again the thick trabecular structure and the cortical cells loaded with medium- and large-sized osmiophilic granula (Fig. 3). In the toads similarly injected with intermedin (*LRW*$_1$ extract of Landgrebe *et al.*[6]), the conditions of the adrenals (Fig. 4) is the same as in the hypophysectomized non-injected toads, which proves that intermedin cannot replace the action of adrenocorticotrophic hormone on the adrenals.

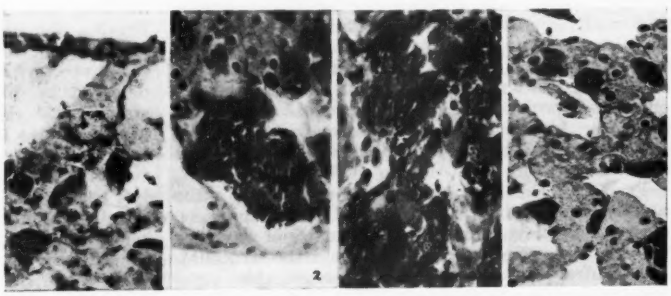
Effect of Intermedin and Adrenocorticotrophic Hormone on the Colour of *Bufo arenarum* Hensel

The hormone preparation (0·1–0·5 ml.) was injected in the dorsal lymph-sac of pale (melanophore index : 1) hypophysectomized toads. Experiments in triplicate

	Amount of hormone (μgm./100 gm.)	Average maximal darkening	Average duration of darkening (hr.)
Intermedin	50	5·0*	102
Adrenocorticotrophic hormone	50	4·5	14
Intermedin	5	5·0	32
Adrenocorticotrophic hormone	5	1·0	0

* Melanophore index 5 corresponds to full dark colour, and 1 to complete paleness (cf. Hogben and Gordon[11]).

Both intermedin and adrenocorticotrophic hormone affect the colour of the *B. arenarum* Hensel. As is shown in the accompanying table, the pale skin of the hypophysectomized toads can be strongly darkened by intermedin and adrenocorticotrophic hormone, but the latter effect is shorter and weaker. The melanocytes of the *B. arenarum* Hensel seem to be more selective in their response to expanding agents than in other species (Stoppani[7]), and therefore their expansion by adrenocorticotrophic hormone may be well attributed to the presence of intermedin or a similar substance. This is confirmed by the increased melanotropic action of adrenocorticotrophic hormone after treatment with boiling 0·1 *N* sodium hydroxide for ten minutes, an effect which is typical of intermedin[6]. It must be pointed out that a preparation of adrenocorticotrophic hormone obtained by the method of Sayers *et al.*[8] from carefully dissected anterior lobes of ox pituitaries still showed melanophore-expanding properties. However, from the evidence summarized in this communication, it must be concluded that the melanotropic action of anterior pituitary extracts (or hormone preparations), which has been known since the earlier observations of Hogben[9] and Houssay and Ungar[10], does not invalidate the classical view that the melanotropic and adrenocorticotrophic actions of the hypophysis are due to different substances.



Photomicrographs of the adrenals of *Bufo arenarum* Hensel (fixation with Champy fluid, × 300): (1) thirty days after hypophysectomy; (2) normal control; (3) same as (1) injected daily with adrenocorticotrophic hormone (100 μgm./100 gm. toad) for fifteen days, starting fifteen days after hypophysectomy; (4) same as (3) but intermedin instead of adrenocorticotrophic hormone. Hæmatoxylin and eosin

We are indebted to Prof. J. Mendive for supplying samples of purified ox adrenocorticotrophic hormone.

A. O. M. Stoppani
P. F. Pieroni
A. Murray

Department of Biochemistry and
Department of Pathology,
School of Medicine,
Buenos Aires.
April 23.

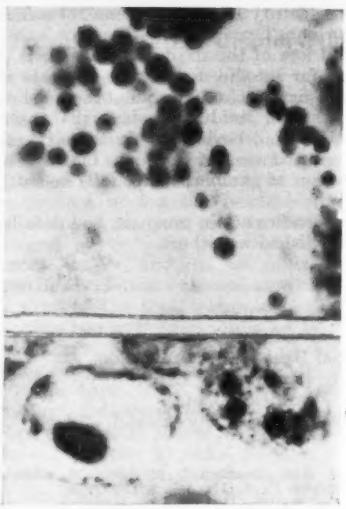
[1] Johnsson, S., and Högberg, B., *Nature*, **169**, 285 (1952).
[2] Sulman, F. G., *Nature*, **169**, 588 (1952).
[3] Geschwindt, I. I., Reinhardt, W. O., and Li, C. H., *Nature*, **169**, 1061 (1952).
[4] Morris, C. J. O. R., *Lancet*, i, 1210 (1952).
[5] Lock, J. A., *Lancet*, ii, 147 (1952).
[6] Landgrebe, F. W., Reid, E., and Waring, H., *Quart. J. Exp. Physiol.*, **32**, 121 (1943).
[7] Stoppani, A. O. M., *J. Pharmacol.*, **76**, 118 (1942).
[8] Sayers, G., White, A., and Long, C. N. H., *J. Biol. Chem.*, **149**, 425 (1943).
[9] Hogben, L. T., "The Pigmentary Effector System", 62 (Oliver and Boyd, London, 1924).
[10] Houssay, B. A., and Ungar, I., *Rev. Soc. Argent. Biol.*, **5**, 173 (1924).
[11] Hogben, L. T., and Gordon, C., *J. Exp. Biol.*, **7**, 286 (1930).

Origin and Fate of the Virus Bundles in Nuclear Polyhedroses

For a close study of the intranuclear cytology of sections of lepidopterous larvæ infected with nuclear polyhedral viruses, it is necessary, in addition to methods for staining the polyhedra[1], to have some method for staining the virus bundles which electron microscopy shows are embedded within the polyhedra. It has been found that this can be done readily, and the origin and fate of the virus bundles can then be traced. Owing to the limitations of ordinary light microscopy, the term virus bundle must perforce be used here to include not only bundles of mature virus rods, but also the bodies of a similar character which are liable to become embedded within polyhedra and within which virus rods may differentiate.

The virus bundles within the polyhedra are rendered visible by treating sections of Carnoy-fixed diseased animals with 1*N* HCl at 60° C. for 10 min., staining in diluted Giemsa for 20 hr., and differentiating in 95 per cent alcohol for 5–20 min. Each virus bundle within and without the polyhedra stains a deep reddish-purple and the polyhedral protein stains a weak pink colour. The distribution of the virus bundles within the smallest and largest polyhedra, the embedding of free virus bundles in already formed and growing polyhedra, the aggregation of polyhedral protein around groups of virus bundles to form polyhedra (as in *Lymantria dispar* and *L. monacha*), and the origin of the virus bundles in the chromatic material can all be readily made out. The species examined have been *L. dispar*, *L. monacha*, *Abraxas grossulariata*, *Panaxia dominula*, *Phlogophora meticulosa*, *Bombyx mori*, and *Ephestia cautella*.

Prior to the formation of recognizable virus bundles and polyhedra in the nuclei of diseased cells, a ring zone devoid of chromatic material develops between the peripheral chromatin and the structureless central chromatic mass. Recognizable virus bundles form at about the time of the transformation of the chromatic mass to a network, and the bundles progressively detach themselves from the mass or strands of the net, where they form, to enter the ring zone. As the virus bundles differentiate from the chromatic material and become free, the strands of the network become greatly depleted in their staining capacity. Most of the freed virus bundles become embedded in the growing polyhedra. Some virus bundles also form in the peripheral chromatic material. No virus bundles have been observed, however, in the cytoplasm of infected cells with still intact nuclei.



(*a*) Polyhedra of *E. cautella* showing stained virus bundles within the polyhedra. Hydrochloric acid pretreatment followed by Giemsa. (× 1,750).
(*b*) Two diseased nuclei of *L. dispar*. One, prior to the formation of free virus bundles and polyhedra, shows a clear ring zone. The other shows developing polyhedra and free virus bundles between them. Hydrochloric acid pretreatment followed by Giemsa. Photographed with green filter. (× 1,750)

The formation of polyhedra in *L. dispar* and *L. monacha* is somewhat atypical, many polyhedra arising from the deposition of polyhedral protein around aggregates of large and varying numbers of virus bundles. In these two species large and also small polyhedra may be found in any given nucleus just beginning to form polyhedra. In the other five species the usual course of events is for a more or less full complement of minute polyhedra, 0·2 μ–0·3 μ in size, to form, and for these polyhedra eventually to grow in size together. The very smallest polyhedra may contain one or no virus bundles, and as they grow, more and more virus bundles become embedded in them.

It may be remarked that the pictures of objects, unstained, within the polyhedra of *L. monacha*, as depicted by Komarek and Breindl[2] from Giemsa-stained material not pretreated with hydrochloric acid, can also be made out in completely unstained material. Though virus bundles can be made out in such material, nevertheless these authors saw far less than could be seen and also mistook diffraction effects as real objects. While Komarek and Breindl's pictures are misleading, the pictures of virus bundles obtained by the method described in this paper are identical in the size, number and distribution of the bundles with the electron microscope pictures of polyhedra lightly treated with alkali. This holds also for the polyhedra of *L. dispar*, *A. grossulariata*, *B. mori*, etc.

Other stains used in this work to stain the polyhedra, etc., have been mercuric bromophenol blue, Altmann's aniline acid fuchsin, methyl green, acid fuchsin followed by methyl green, and Schiff's reagent. The polyhedral virus attacking the economically important pest of stored products, *E. cautella*, was recently found by Dr. K. M. Smith and myself. Full details of the work will be published elsewhere.

N. Xeros

Plant Virus Research Unit
(Agricultural Research Council),
Molteno Institute,
Cambridge.
June 24.

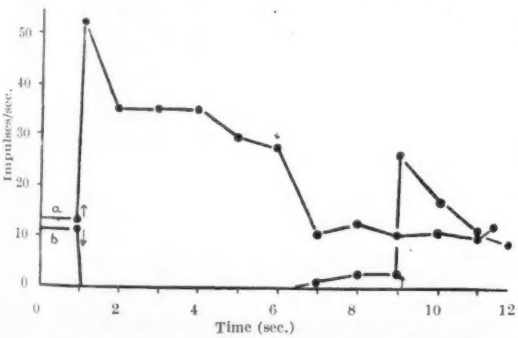
[1] Xeros, N., *Nature*, **171**, 309 (1953).
[2] Komerek, J., and Breindl, V., *Lesnicke prace, rocnik* **2**, 1 (1923).

Effect of Galvanic Polarization on the Impulse Discharge from the Horizontal Ampulla of the Isolated Elasmobranch Labyrinth

Experiments have been carried out on the isolated labyrinth of the elasmobranch fish *Raja clavata*, with the object of studying the effect of galvanic polarization on the behaviour of the sense endings in the crista of the horizontal semicircular canal. The electrical responses of this organ to rotatory stimulation have been fully analysed and described in previous papers[1,2]. Reference should be made to Lowenstein and Sand[1] for a detailed description of the method employed in making the physiological preparation and the oscillographic recording from the ampullary nerve.

This particular preparation offers a good opportunity to test some aspects of the 'generator potential hypothesis', according to which a galvanic potential intervenes between the mechanical deformation of the receptor cell or its associated auxiliary structures and the stream of discrete afferent impulses conducted along the sensory nerve[3-7].

By means of various devices, including an electronic high impedance D.C. stimulator, ascending and descending currents ranging from a fraction of a μamp. to a few μamp. were channelled through the strand of the sensory nerve from which the impulse responses were being recorded. The effects of such polarizing currents on the discharge activity of single sensory units are shown in the accompanying graph.



Impulse discharge rates from a single sensory unit of the horizontal canal crista in response to ascending (*a*) and descending (*b*) polarizing currents. Basic discharge rates 13 and 11 imp./sec. respectively. Arrows at make and break of polarizing current

The making of an ascending current flowing from the central end of the divided nerve strand towards the sensory epithelium causes an immediate rise in the basic rate of the impulse discharge (see trace *a*). During the period of maintained current flow, the discharge rate gradually falls (adaptation). Break of the ascending current usually produces post-excitatory depression of the discharge rate below the basic level, to which it finally returns (decay of the post-excitatory after-effect). This after-effect happened to be not very pronounced in the experiment illustrated in the graph. Descending currents have the opposite effect (see trace *b*). They cause marked inhibition to total abolition of the basic discharge. Adaptation during the maintained current flow leads to the gradual reappearance of the discharge activity, and the break of the descending current is followed by an instantaneous rise in the discharge rate above the basic level. The basic rate is finally restored by a decay of the post-inhibitory after-effect.

The behaviour of the sense ending is thus closely reminiscent of its response to natural rotatory stimulation, where rotation in opposite directions either increases or decreases the frequency of a basic discharge. Ascending and descending currents correspond in their excitatory and inhibitory effects to ipsi- and contralateral angular acceleration respectively. The agreement is complete and extends to the reproduction of the post-rotatory after-effects.

In the experiment illustrated by the graph the galvanic 'stimulus' was applied and removed by the action of a switch. It could, therefore, be suggested that we are dealing here with responses to cathodic or anodic make and break as such, and not to the continued flow of galvanic current. In order to remove this doubt, experiments were carried out in which the excitatory and inhibitory currents were slowly raised from sub-threshold to maximum, or where a smooth transition from maximum inhibitory current through zero to maximum stimulatory current and vice versa was effected by means of the electronic D.C. stimulator. Records so obtained showed quite unambiguously that the sense endings respond to a continuous change in polarizing current with a correspondingly smooth change in discharge frequency. The levels of activity correlated with various strengths of polarizing current are maintained for many minutes, but there is always a certain amount of 'adaptation' from the level attained immediately after the change in galvanic polarization.

It is clear from these results that D.C. polarization influences the vestibular discharge activity. The fact that this influence extends both to total inhibition of basic activity and to the evocation of impulse discharge in previously silent sensory units represents highly suggestive circumstantial evidence in favour of the assumption that such D.C. potentials could, in fact, be a physiological link in the chain of events taking place between the mechanical deformation of part of the sensory cell and the discharge of the train of discrete sensory impulses in the afferent nerve. It is also of interest that a basically silent sensory unit can be made to discharge as easily by the removal of an inhibitory current as by the imposition of an excitatory one.

With regard to the question of the localization of the galvanic effect, this may plausibly be assumed to take place at the end arborizations of the sensory nerve where they are applied in synaptic fashion to

the cell bodies of the secondary sensory cells. This interpretation is also advocated by Katsuki[7] in his work on the effect of linearly rising currents on the lateral line end-organs. It now appears that there is a good case for applying the generator potential hypothesis to the whole of the vertebrate acusticolateralis system, thus bringing the interpretation of its mode of function into line with that proposed by Granit and his co-workers for the retinal receptors or associated nervous structures in the eye.

Work on the quantitative analysis of stimulus response relationships with special reference to the adaptive behaviour of the end-organs is in progress. A full account of the results will be published elsewhere. The work was supported by a Royal Society Grant-in-aid of Scientific Investigations.

Otto Lowenstein

Department of Zoology and
Comparative Physiology,
University,
Birmingham 15.
June 22.

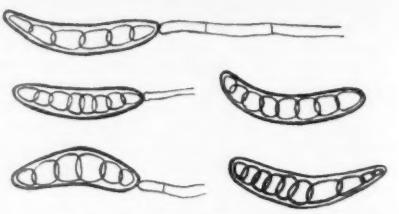
[1] Lowenstein, O., and Sand, A., *Proc. Roy. Soc.*, B, **129**, 256 (1940).
[2] Groen, J. J., Lowenstein, O., and Vendrik, A. J. H., *J. Physiol.*, **117**, 329 (1952).
[3] Skoglund, C. R., *Acta Physiol. Scand.*, **4**, Supp. 12, 1 (1942).
[4] Granit, R., "Sensory Mechanisms of the Retina" (Oxford, 1947).
[5] Jielof, R., Spoor, A., and de Vries, H. L., *J. Physiol.*, **116**, 137 (1952).
[6] Davis, H., Tasaki, J., and Goldstein, R., Cold Spring Harbor Symp. Quant. Biol., **17**, 143 (1952).
[7] Katsuki, Y., *Jap. J. Physiol.*, **2**, 93 (1951).

Occurrence in Nature of an Alternative Host (*Leersia hexandra* Sw.) of *Helminthosporium oryzæ* Breda de Haan

Helminthosporium oryzæ Breda de Haan, the causal organism of sesame leaf spot of paddy, has not yet been found to attack any other Graminaceous or other host plants in Nature with the single exception of *Oryza montana* from Togo reported by Roger[1]. Ocfemia[2] and Nisikado and Miyake[3] were able to obtain infection on a number of grasses under artificial conditions; similarly, Shaw[4] noted infection under artificial conditions of inoculation on maize, sorghum, oats and barley; Tochinai and Sakamoto[5] on maize, wheat, rye and barley; and Thomas[6] on *Elusine coracana*, *Pennisetum typhoides*, *Setaria italica*, oats, maize, wheat and sugar-cane.

In the course of search for an alternative host of *Helminthosporium oryzæ* in paddy fields at Chinsurah, we found a common perennial grass (*Leersia hexandra* Sw.) occurring in the bundhs of paddy fields with small oval spots of *Helminthosporium oryzæ* type measuring 0·5–3 mm. × 0·5 mm. in size, deep brown in colour with greyish centre, on the leaf blades. The bits of infected leaf blades when kept in sterile moist Petri dishes for forty-eight hours after surface sterilization developed conidia of the *Helminthosporium oryzæ* type measuring 33–125 μ × 9–19 μ with 5–9 septa, brown, straight to curved, cylindrical to elliptical, tapering towards both the ends, more so towards the apical end, without any prominent attachment region or hilum. They are borne on conidiophores measuring 150–350 μ in length and brown in colour.

The pathogen was isolated from the host in the usual way and monosporous cultures were made. Studies, under artificial conditions, of the culture were made to find out the relationship of the isolate from grass with *Helminthosporium oryzæ*. The isolate from the grass produced good mycelial growth on Richard's solution agar, oat agar and maize meal agar at 28–30° C. The mycelium was deep brown to black in colour with inconspicuous zonation. Conidia were formed on maize-meal agar. They were borne on conidiophores measuring 150–350 μ in length by 4–7 μ in breadth, dark brown in colour and arising as lateral branches from the vegetative hyphæ. Conidia were cylindrical to elliptical, straight to curved, widest at the middle, tapering towards both ends which were rounded, brown in colour, measuring 33–130 μ × 9–18 μ with 5–11 septa averaging 84 μ × 14·6 μ with 6–8 septa. Germination of the conidia was found to be bipolar, germ tubes arising from the two end-cells. Microscopic observations revealed the presence of hyphal fusions between the isolate from the grass (*Leersia hexandra* Sw.) and *Helminthosporium oryzæ* isolated from leaves of *Oryza sativa*, when grown beside it in 0·2 per cent agar on glass slide.



Helminthosporium oryzæ. Conidiophores and conidia from the infected leaf of the grass *Leersia hexandra* Sw., Chinsurah, West Bengal. (× *c.* 300)

Pathogenicity tests were carried out on both the grass (*Leersia hexandra* Sw.) and paddy (variety Bhasamanik) with the isolate from grass as well as with *Helminthosporium oryzæ* Breda de Haan, isolated from infected leaves of Asra variety of paddy at Chinsurah, West Bengal. On paddy the isolate from the grass readily produced infection. The spots produced were oval, younger ones being circular, deep brown in colour, with greyish centre, measuring 1–3·5 mm. × 0·5–1 mm. in size. On grass also, it produced similar infection. *Helminthosporium oryzæ* isolated from Asra paddy produced spots on the grass *Leersia hexandra* Sw., brown in colour, circular to oval in shape, measuring 1–2 mm. × 0·5–1 mm. in size—similar to those produced on Bhasamanik variety of paddy by the same fungus. Re-isolations made in each of the cases of cross-inoculation, namely, from both the grass *Leersia hexandra* Sw. and *Oryza sativa*, inoculated by both the isolate from the grass and *Helminthosporium oryzæ*, gave cultures identical to those used for infection.

S. B. Chattopadhyay
N. K. Chakraborti

State Agricultural Research Institute,
Government of West Bengal,
Tollygunge, Calcutta.
April 23.

[1] Roger, L., *Agron. Colon.*, **24**, 215, 139 (1935)
[2] Ocfemia, G. O., Abs. in *Phytopath.*, **13**, 53 (1923).
[3] Nisikado, Y., and Miyake, C., *Ber. Ohara. Inst. Landw. Forsch.*, 2, 193 (1922).
[4] Shaw, F. J. F., Report of the Imperial Mycologist, Sci. Rep. Agric. Res. Inst., Pusa, 1920–21, 34 (1921).
[5] Tochinai, Y., and Sakamoto, M., *J. Fac. Agric., Hokkaido Univ.*, **12**, 1 (1937).
[6] Thomas, K. M., Detailed Administration Report of the Government Mycologist, Madras, for the year 1939–40, 18 (1940).

Activity of the Incretory Centres of *Locustana pardalina* during Embryogenesis: Function of the Prothoracic Glands

EVINCED in insects is the existence of a tripartite endocrine system, and a composite hormonal mechanism. A brain factor liberated by the neurosecretory cells of the pars intercerebralis induces the prothoracic glands (ventral glands, pericardial glands, lateral cells or peritracheal glands of Weismann) to secrete their contributive hormone[1]. There is also abundant proof that the 'juvenile hormone' of the corpora allata promotes differentiation and growth in the larval direction[2]. However, there was much that still remained obscure about the particular function of the hormone secreted by the prothoracic glands.

The discovery of a pair of distinct glandular organs (prothoracic glands) in embryos of *Locustana pardalina* led to investigating the activity of the different incretory centres in relation to each other, and to the moult of provisional cuticle during embryogenesis.

Dried eggs of *Locustana* containing dormant embryos were wetted and kept at 30° C., 100 per cent relative humidity. Exposure to these conditions was responsible for a re-commencement of development. This was accompanied by a conspicuous enlargement of the neurosecretory cells. They maintained obvious histological signs of maximal secretory activity for 72 hr. After 96 hr., when katatrepsis was completed, their activity subsided, and thereafter it became practically impossible to distinguish them from ordinary nerve cells.

The prothoracic glands were first located with confidence on the completion of katatrepsis. They reached their maximal size and activity in the cycle 24 hr. later. The nuclei became more densely stained, and many of them became enlarged and slightly lobulated. However, the main point of interest was that this period of maximal activity of the glands coincided with the retraction of the epidermis from already formed cuticle. Thereafter, the glands became noticeably reduced in size, and at the time of emergence they were less than half their former peak size.

The corpora allata obtained their customary form and position on each side of the œsophagus in 96 hr. They showed no visible histological changes.

In view of the observed correlation between the maximal activity of the prothoracic glands and the embryonic moult, ligaturing tests were attempted on dissected-out embryos which had just completed katatrepsis. This was about 24 hr. before they were normally due to moult. The detached provisional cuticle resulting from the moult formed an easily detectable envelope. In four cases in a batch of twenty ligatured between the thorax and the abdomen, and examined 24 hr. later after being kept moist with isotonic solution, the thorax, but not the abdomen, moulted. Attempts to isolate the head gave uncertain results, but in two cases in a batch of twenty-two the body only appeared to moult.

Important conclusions to be drawn from the above evidence are as follows. First, the effectiveness of wetting the eggs terminating dormancy may be explained in terms of an action of moisture inducing the brain to liberate a developmental factor. Chilling the brain of the *Cecropia* silk-moth produces the same effect[1]. Secondly, the tissues were made competent to differentiate prior to the proper formation of either the prothoracic glands or the corpora allata. Thirdly, subsidence in the activity of the neurosecretory cells was followed by the prothoracic glands attaining their maximal size and activity. These glands appeared to be exclusively responsible for the retraction of the epidermis from its cuticle.

It is hoped to publish the details elsewhere with Mr. Sharan of this Department. Dr. Matthée, of the Agricultural Research Institute, Pretoria, very kindly made the locust egg-pods available for this work.

BRYN M. JONES

Department of Zoology,
University of Edinburgh.

[1] Williams, C. M., *Biol. Bull.*, **93**, 89 (1947).
[2] Wigglesworth, V. B., *J. Exp. Biol.*, **29**, 620 (1952).

Sorghum Midge and Resistant Varieties in the Gold Coast

FAILURE of *Sorghum* to set seed has occasionally been noted in annual reports of the Gold Coast Agricultural Department, and attributed to climatic conditions. In view of the importance of this crop in the Northern Territories, investigations were commenced and have shown that this failure is due primarily to attacks by the sorghum midge, *Contarinia sorghicola* Coquillet.

Preliminary results from sample surveys showed increasing infestation as the flowering season progressed. A range of from approximately 20 per cent midge-infected grains in early-flowering varieties to 80 per cent in a late-flowering crop was recorded at the Nyankpala Agricultural Station, Tamale (9° 25′ N., 0° 95′ W.) in 1952. Comparable figures were obtained at Manga Agricultural Station, Bawku (11° 5′ N., 0° 15′ W.).

Variety plots indicated the value of early flowering as an escape from attack; but in addition one group of varieties showed apparent resistance. This group—of which Nunaba is the typical variety—has certain distinctive characters, including long papery glumes which do not normally open at anthesis. It appears that, as a result of this, the midge has difficulty in ovipositing within the glumes.

Sample counts showed 3 per cent infestation in Nunaba compared with 35 per cent in a variety which flowered normally at the same time.

A further result of the non-opening of the glumes is that natural hybridization rarely occurs. This character would have the additional practical advantage, therefore, of facilitating the maintenance of pure varieties.

The lack of natural hybrids may account for the fact that varieties with this character, which differ from one another only in minor details, are found only in the North-Eastern District of the Gold Coast.

In an effort to introduce the non-opening glume character into a wider range of types, a number of crosses have been made involving Nunaba and related varieties. It is difficult to collect pollen from these since the anthers remain enclosed within the glumes, but they may readily be used as female parents provided the glumes are clipped to expose the stigma immediately before pollination.

J. BOWDEN
(Entomologist)
R. A. NEVE
(Plant Breeder)

Department of Agriculture,
Accra, Gold Coast. April 22.

Heartwood Formation in *Pinus radiata* (D. Don)

In a paper which is to be published by the New Zealand Forest Service entitled "Heartwood Formation in *Pinus radiata*", it has been shown that conditions which are conducive to the occurrence of physiological drought retard heartwood formation in this species, but that where a deep root system can be developed in an area with adequate rainfall but without drying winds or low humidity heartwood formation is at a maximum. These findings are based on the statistical analysis of data from two hundred trees felled on twelve widely contrasted growing sites.

A further study of the bordered pits of wood tracheids in each growth layer from the cambium to the coloured heartwood suggests a mechanism whereby a maximum volume of sapwood would be retained to meet the demands of recurrent physiological drought. The percentage of bordered pits aspirated in a cross-sectional disk from a freshly felled tree is at a minimum (less than 5 per cent) in the outermost annual growth layers, and increases in a regular manner according to the number of growth layers to 50 per cent in the innermost layers of sapwood. In the zone of 'dry' wood (moisture content, 40 per cent) which characteristically surrounds the coloured heartwoods more than 95 per cent of the pits are aspirated, and this condition is maintained in the coloured heartwood. Thirty trees have been investigated in this way and observations made of some twelve thousand bordered pits. This distribution of aspirated pits is independent of site quality.

The degree of saturation of the wood, estimated from green and oven-dry measurements and the known fibre saturation point of the timber, is completely compatible with the concept that aspirated pits arise where a tracheid wall lies between one tracheid containing gas and one containing water. The degree of saturation in terms of pit aspiration must, of course, make due allowance for the fact that an isolated tracheid void of water influences the pits on two (radial) walls, whereas two contiguous voided tracheids cause aspiration of the pits of only three walls, the one wall being common to both tracheids. Thus 50 per cent pit aspiration implies 69 per cent saturation or that 31 per cent of the tracheids are devoid of water.

I am indebted to Mr. E. Lewis, biometrician at this Institute, for showing statistically that when more than 50 per cent of the pits are aspirated the apertures remaining open can no longer be considered to provide a continuous conducting system. If one accepts the findings of Stamm[1] that any openings which occur in the cell wall other than those present in the pit membrane are not of a size to provide passage for the penetration of liquids, it implies that the sapwood immediately contiguous to the heartwood is no longer a conducting system. The water in this tissue is therefore not subject to transpiration tension transmitted through the pits but becomes freely available to the living cells of the wood rays and epithelial cells of the resin canals for the hydrolysis of stored food which is lost in this zone.

It is suggested that during conditions of physiological drought when transpiration tensions are high the tension will not only be transmitted along the outer layers of sapwood which lie in a direct line between the transpiring leaves and the root hairs, but will also be transmitted with decreasing intensity across the resistance offered by successive growth layers and thence downward through the inner sapwood. While tension within the sapwood remains high the water is not freely available to the living cells. If, however, the tension in the outer layer of wood is not very great, the force is greatly reduced before many growth layers are crossed, and in this case the water in tracheids at a lesser distance from the cambium becomes freely available to the living cells. As this water is used, more bordered pits will become aspirated until eventually the critical point is reached when 50 per cent of the pits are aspirated, the free water remaining becomes readily available, and the central core of wood is 'dried out'. Absence of physiological drought therefore permits the acceleration of the processes leading to loss of water from the central core of wood, which is an essential first step in the formation of heartwood in pines, resulting as it does in the death of all cells and the accumulation of resins which undergo both physical and chemical changes during the formation of coloured heartwood.

J. Maddern Harris
(Assistant Timber Physicist)

Forest Research Institute,
P. B. Whakarewarewa,
Rotorua, New Zealand.

[1] Stamm, A. J., *J. Phys. Chem.*, **36** (1932).

Sterilization of Timber with Methyl Bromide

The effectiveness of methyl bromide as a fumigant for insect-infested timber has been reported by Burden and McMullen[1]. In view of its use as a fungicide for soil sterilization, it seemed desirable to investigate its value as a sterilizing agent for timber infected by staining and wood-destroying fungi.

Blocks of Norway spruce (*Picea abies* (L.) Karst), 5 in. by ½ in. by ½ in., were set in two inches of moist soil in large test-tubes which were then autoclaved at 15 lb. per sq. in. for 30 min. After inoculation with the test organisms (see accompanying table), duplicate series of blocks were incubated at room temperature for nine weeks. Good growth was obtained in all cases, no contamination being observed. The blocks were then subjected to a vacuum in a large desiccator (which procedure was found to have no adverse effect on the fungi) and a measured volume of methyl bromide introduced. Various combinations of gas concentration and fumigation time were used (see table). After fumigation, isolations were made from the wood blocks on to malt agar and incubated at 27° C. The plates were examined daily for a period of one month, and the results are shown in the accompanying table.

From the results obtained, the most effective treatment tested was 12 lb. per 1,000 cu.ft. for 96 hr.; but 20 lb. per 1,000 cu.ft. for 24 hr. also appeared moderately effective. In a preliminary experiment lower concentrations of methyl bromide were found to be ineffective against the test organism. No significant difference was noted in isolations made from either the surface or interior of the blocks. Similarly, no apparent difference was noted when the blocks were incubated for one week after fumigation as compared with isolates made within a few hours after treatment.

These results suggest the possible use of methyl bromide as a fumigant for the sterilization of fungal

RELATIVE GROWTH OF FUNGI AFTER FUMIGATION WITH METHYL BROMIDE

Methyl bromide concentration	6 lb./1,000 ft.³	6 lb./1,000 ft.³	12 lb./1,000 ft.³	20 lb./1,000 ft.³	Untreated control
Fumigation time	24 hr.	72 hr.	96 hr.	24 hr.	
Species:					
Aspergillus niger van Tiegh.	++	++	−	−	++
Basidiomycete No. X 28*	++	++	−	−	++
Ceratostomella picea Münch.	−	−	−	−	++
Lentinus lepideus Fr.	++	++	−	−	++
Lenzites trabea (Pers.) Fr.	++	−	−	+	++
Poria vaporaria (Pers. ex Fr.) Cooke	−	++	−	−	++
Trametes cinnabarina (Jacq.) Fr.	++	++	−	−	++
Trichoderma viride Pers. ex Fr.	++	++	−	++	++

Normal growth is denoted by ++; poor growth is denoted by +; no growth is denoted by −.
* Unidentified Basidiomycete isolated from Klinkii pine (*Araucaria klinkii* Lauterb) imported from New Guinea.

infected timber, especially in large stocks or where heat treatment may be undesirable or impracticable. Since the discovery of Siricid wasp larvæ in imported timber during 1951, large-scale fumigation of timber with methyl bromide under plastic tarpaulins has been used extensively in Australia[2]. It should be emphasized that the process is one of sterilization rather than preservation. Further work on this project is not contemplated at present.

J. B. CARTWRIGHT
D. W. EDWARDS
M. J. MCMULLEN

Division of Wood Technology,
N.S.W. Forestry Commission,
Sydney, Australia.
June 12.

[1] Burden, J., and McMullen, M. J., *Aust. J. Sci.*, **14**, 57 (1951).
[2] McMullen, M. J., Technical Notes, Div. Wood Tech., Forest Comm. N.S.W., **6**, Nos. 3/4 (in the press).

Testing of Two Samples

VARIOUS methods, parametric and non-parametric, are used for examining the significance of the difference between two given samples. The most common of these is the parametric one, the *t*-test[1], which is based on the assumption that the samples are drawn from a normal population. There is Pitman's[2] *u*-test which has been built up by considering all the possible samples that can be drawn by pooling together the two samples. Besides these, Wald and Wolfowitz[3] have used the run theory for deciding the significance of the difference between two samples. This method has been extended for k samples by myself[4]. Recently, tests have been constructed by Wallis[5], Kruskall[6] and Rijkoort[7] by using rank numbers for each of the samples.

It will be seen that the first method does not give any consideration to the order of occurrence of the individuals in the sample. The second, third and fourth methods mentioned above are based on the assumption that the probability for the occurrence of any individual depends only on the two samples together and do not take into account the magnitude and the relationship between the order of the individuals in the two samples. The object of this note is to give some tests which take both the above factors into consideration.

Suppose there are two samples of size n, the individuals of which take the values $\theta_1, \theta_2, \ldots \theta_k$ with probabilities $p_1, p_2 \ldots p_k$. Let the individuals of the samples, taken in the order of occurrence, be as follows:

$$\left.\begin{array}{ll} \text{Sample I} & x_1, x_2, \ldots \quad x_n \\ \text{Sample II} & y_1, y_2, \ldots \quad y_n \end{array}\right\}$$

Consider the distributions of X and Y defined by

$$X = \sum_{r=1}^{k} | x_r - y_r | ,$$

$$Y = \Sigma | x_r - y_r | + \Sigma | x_{r+1} - y_r | + \Sigma | x_r - y_{r+1} | .$$

The expectation and the variance of X and Y are as follows:

$$E(X) = n \sum_{r,s=1}^{k} | \theta_r - \theta_s | p_r p_s = n\varphi,$$

$$V(X) = n[\Sigma (\theta_r - \theta_s)^2 p_r p_s - \varphi^2] = nv,$$

$$E(Y) = (3n - 2)\varphi,$$

$$V(Y) = (3n - 2)\, v + 4\,(3n - 4)\,[2\Sigma(| \theta_r - \theta_s | \, | \theta_s - \theta_t | + | \theta_r - \theta_t | \, | \theta_t - \theta_s | + | \theta_t - \theta_r | \, | \theta_r - \theta_s |) p_r p_s p_t + \Sigma(\theta_r - \theta_s)^2 \, p_r p_s (p_r + p_s) - \varphi^2].$$

The third and the fourth cumulants and, in fact, the higher cumulants of both X and Y can all be shown to be linear in n, the number of observations in the sample, and therefore the distributions tend to the normal form as n increases.

The two distributions considered here, and also their extensions, can be used for deciding whether two samples of moderate sizes can be considered as belonging to the same population. This can be done by comparing the standardized deviates of X and Y for the given samples, assuming the p's to be that obtained by pooling them together.

It may also be noted that it may be possible to have an optimum test by considering the distribution of

$$\left.\begin{array}{l} \Sigma | x_r - y_r | + \Sigma | x_{r+1} - y_r | \ldots \Sigma | x_{r+s} - y_r | \\ + \Sigma | x_r - y_{r+1} | + \Sigma | x_r - y_{r+2} | \ldots \Sigma | x_r - y_{r+s} | \end{array}\right\}$$

in which s will have to be so determined that the standardized deviate is a maximum. Also, instead of taking the p's as determined by pooling together the two samples, we may estimate them for given s by maximizing the standardized deviate.

It is hoped to discuss all these points in detail in a communication to be published elsewhere.

P. V. KRISHNA IYER

Defence Science Organization,
New Delhi.
March 20.

[1] Fisher, R. A., "Statistical Methods for Research Workers" (10th edit., Oliver and Boyd, Edinburgh, 1946).
[2] Pitman, E. J. G., *J. Roy. Stat. Soc., Supp.*, **4**, 119 (1937).
[3] Wald, A., and Wolfowitz, J., *Ann. Math. Stat.*, **11**, 147 (1910).
[4] Krishna Iyer, P. V., *J. Ind. Soc. Agric. Stat.*, **1**, 173 (1948).
[5] Wallis, W. A., *Industrial Quality Control*, **8**, 35 (1952).
[6] Kruskall, W., *Ann. Math. Stat.*, **23**, 525 (1952).
[7] Rijkoort, P. J., *Proc. Nederl. Akademie van Wetenschappen, Amsterdam*, **14**, 304 (1952).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, September 21

Institute of Metal Finishing (at the Northampton Polytechnic, St. John Street, London, E.C.1), at 6 p.m.—Dr. J. Edwards: "The B.N.F. Jet Test on Organic Bright Nickel Deposits".

Tuesday, September 22

Society of Chemical Industry, Plastics and Polymer Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Prof. C. E. H. Bawn: "The Viscosity of Polymer Solutions".

Wednesday, September 23—Saturday, September 26

Society of Dyers and Colourists (at St. Annes-on-Sea).—Symposium on "Textile Printing".

Thursday, September 24

Television Society (at the Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, London, W.C.2), at 7 p.m.—Mr. D. D. Jones: "Transistors and Other Crystal Valves".

Friday, September 25

British Society of Rheology (in the Main Chemistry Lecture Theatre, Imperial College, Imperial Institute Road, London, S.W.7).—Symposium on "Mixing of Thick Liquids, Pastes and Slurries".*

Hospital Physicists' Association (in the Upper Lecture Theatre, Room 141, L Block, Hammersmith Hospital, Ducane Road, London, W.12), at 8.15 p.m.—Dr. A. Glucksmann: "Radiosensitivity at Different Levels of Biological Complexity" (Third Douglas Lea Memorial Lecture).*

Saturday, September 26

Society of Public Analysts and Other Analytical Chemists, North of England Section and the Microchemistry Group (joint meeting with the Liverpool and North-Western Section of the Royal Institute of Chemistry, at the Town Hall, Southport), at 2.30 p.m.—Symposium on "Training and Education of Microchemists".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer (with degree or a recognized diploma in mining) in the Department of Mining and Geology—The Principal, Wigan and District Mining and Technical College, Wigan (September 28).

Research Fellow (with qualifications that are basically physico-chemical and/or biochemical, with preferably a leaning towards biological problems) in the Departments of Dermatology and Biomolecular Structure, to carry out fundamental investigations on the structure of the skin in health and disease—The Registrar, The University, Leeds 2 (September 28).

Research Assistant in the Department of Biochemistry for work of a physico-chemical nature—The Secretary, University College, Gower Street, London, W.C.1 (September 30).

Senior Research Officer or Research Officer (with honours degree, with botany as a major subject) in the Commonwealth Scientific and Industrial Research Organization, Division of Plant Industry, to undertake detailed botanical studies of introduced plants which have shown promise in Australia—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2 (September 30).

Guide Lecturer (with degree or equivalent qualification in science or engineering) at the Science Museum—The Civil Service Commission, Scientific Branch, Seventh Floor, Trinidad House, Old Burlington Street, London, W.1, quoting S.4248/53 (October 1).

Lecturer or Assistant Lecturer in Pharmacology at the University College of the West Indies—The Secretary, University of London Senate Committee on Higher Education in the Colonies, Malet Street, London, W.C.1 (October 1).

Research Assistant in Metallurgy to carry out work on the mechanical testing of metals—The Registrar, The University, Manchester 13 (October 1).

Staff-Tutor (with high academic qualifications, preferably in science or art)—The Director of Extra-Mural Studies, 91 Oakfield Avenue, Glasgow, W.2 (October 2).

Engineer (with H.S.C. (science) or equivalent, but degree or H.N.C. may be an advantage) at the Ministry of Supply Tropical Testing Establishment, Port Harcourt, Nigeria, to assist in study of effects of tropical conditions on Service materials and equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.222/53A (October 3).

Electrical Engineers (preferably with first- or second-class honours degree in engineering) in the Admiralty—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.210/53 (October 8).

Senior Assistants (Scientific) for work involving the observation and recording of critical experiments of a long-term nature carried out at the Experimental Husbandry Farms and Experimental Horticulture Stations of the National Agricultural Advisory Service—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S4252/53 (October 8).

Assistant Lecturer in Physics—The Registrar, The University, Manchester 13 (October 10).

Lecturer in Clinical Chemistry—The Secretary, The University, Aberdeen (October 15).

Lecturer or Senior Lecturer (with degree in mechanical engineering) in Mechanical Engineering at Canterbury University College, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 15).

Principal Scientific Officer (with first- or second-class honours degree, preferably in mathematics, physics or engineering, or equivalent qualifications, and some postgraduate research experience) in the Department of Scientific and Industrial Research, Mechanical Engineering Research Laboratory, East Kilbride, Glasgow, to lead a team engaged on the thermodynamic tables programme of the Heat Division and the numerical analysis and correlation of experimental data relating to functions of two variables—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4247/53 (October 20).

Principal (with high qualifications, and responsible experience either in the field of technical education or administration, or in industry; preferably in both) of the College of Technology, Bristol—The Chief Education Officer, Council House, College Green, Bristol 1 (October 24).

Assistant Director (graduate in engineering, physics, chemistry or microbiology, and experience of research in the preservation, processing and transport of food, preferably fish)—The Secretary, Fishing Industry Research Institute, P.O. Box 1233, Cape Town, South Africa (November 16).

Chair of Botany, and Chair of Geology—The Secretary, Queen's University, Belfast (November 20).

Lecturer in Physiology at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 30).

Chemist, Senior Scientific Officer or Scientific Officer grade (with good honours degree and appropriate research experience), for research on problems of metabolism in the dairy and cow on the composition and digestibility of feeding-stuffs—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, Berks, quoting 53/15.

Entomologist (with good honours degree in zoology or agricultural zoology, and at least two years postgraduate experience or training in entomology) in the Department of Agriculture, Trinidad, for investigation of plant damage by insects and other animals and formulation and application of control measures; also plant quarantine work—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CSC.63/38/01.

Lecturer (graduate in Agricultural Chemistry or Biochemistry) in Agricultural Chemistry—The Registrar, The University, Nottingham.

Lecturer in Pig Husbandry in the Dairy Husbandry Department—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1, or The Registrar, Massey Agricultural College, Palmerston North, New Zealand.

Lecturer or Assistant Lecturer in the Department of Electronics—The Secretary and Registrar, The University, Southampton.

Physical Chemist for research work on flour quality—Director, Research Association of British Flour Millers, Cereals Research Station, Old London Road, St. Albans.

Research Assistant (with degree in agriculture and practical experience of pig production) in the Pig Research Department, for recording basic experimental data and assisting with research—The Registrar, Wye College, Ashford, Kent.

Senior Geographer (with good honours degree in geography with surveying at an advanced standard and preferably with physical geography or geomorphology as a subsidiary subject, and with several years practical experience or postgraduate research) in the Department of Soil and Land Use Survey, Gold Coast, to carry out topographical survey work in connexion with soil surveys, soil conservation schemes and irrigation projects; to train locally recruited junior officers and to assist in the interpretation of and produce approximate maps from aerial photographs—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.79/13/04.

Senior Lecturer (with degree, preferably higher, in either agricultural, veterinary or pure science) in Physiology of the Sheep, in the Sheep Husbandry and Wool Department, to lecture on the physiology of growth and reproduction in the sheep and the nutrition of sheep—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1, or The Registrar, Massey Agricultural College, Palmerston North, New Zealand.

Senior Scientific Officer or Scientific Officer (with university degree or equivalent qualification and preferably with experience in ergonomic techniques) for research on the responses of human operators controlling steelworks plant, with special reference to the design and layout of control points in order to reduce fatigue and improve speed and efficiency of operators—Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831. Telegrams: Phusis Lesquare London

Annual subscription £6, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to
T. G. Scott & Son, Ltd., Crown House, 143–147 Regent Street, London, W.1
Telephone Number: Regent 3891

All rights reserved. Registered as a newspaper at the General Post Office